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# OBSTETRICS







PLATE I.



VERTICAL MESIAL SECTION THROUGH BODY OF WOMAN DYING IN LABOR,  
WITH UNRUPTURED MEMBRANES PROTRUDING FROM VULVA.

# OBSTETRICS

*A TEXT-BOOK FOR THE USE OF STUDENTS  
AND PRACTITIONERS*

BY

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*THIRD ENLARGED AND REVISED EDITION*

WITH SIXTEEN PLATES AND  
SIX HUNDRED AND SIXTY-EIGHT ILLUSTRATIONS IN THE TEXT



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TO  
WILLIAM H. WELCH  
PROFESSOR OF PATHOLOGY, JOHNS HOPKINS UNIVERSITY  
AND  
WILLIAM T. COUNCILMAN  
PROFESSOR OF PATHOLOGY, HARVARD UNIVERSITY  
AS AN EXPRESSION OF RESPECT  
AND AFFECTION

47017



## PREFACE TO THE THIRD EDITION

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THE demand for a third edition of this work seems to indicate that it has served a useful purpose, and I hope that the present revision may add to its value.

The entire work has been thoroughly revised and, although its general arrangement is unchanged, there is scarcely a chapter which has not been materially altered. The most important changes are to be found in the chapters upon the development of the ovum, the organic changes incident to pregnancy, pubiotomy, and Cæsarean section, pernicious vomiting of pregnancy, and the frequency of contracted pelvis and the treatment of labor complicated by it. This has necessitated increasing the size of the book by 26 pages, which has been accomplished only by radical excision in many sections.

Notwithstanding the objections which have been offered by certain friendly critics, I have retained and brought up to date the literary references at the end of each chapter. No attempt has been made to present a complete bibliography, as the references are limited to those which I have actually consulted. No doubt their presence adds materially to the size of the book, and I know that their compilation and verification have greatly increased my labor, but if they lead, as I hope they may, one student in a hundred to consult an original article occasionally, and to appreciate that our art and science is based upon myriads of contributions from all parts of the world, they will have served a valuable educational purpose.

I am under many obligations to my secretary for valuable aid in the revision, as well as for the preparation of the index.

1

## PREFACE TO THE FIRST EDITION

---

IN the following pages I have attempted to set forth, as briefly as seemed to be consistent with thoroughness, the scientific basis for and the practical application of the obstetrical art.

Especial attention has been devoted to the normal and pathological anatomy of the generative tract. At the same time I have endeavored to present the more practical aspects of obstetrics in such a manner as to be of direct service to the obstetrician at the bedside.

No pains have been spared in illustrating the work, although mere artistic effect has necessarily often been sacrificed to accuracy and practical teaching qualities. With the exception of those relating to pure embryology, all illustrations representing microscopical sections have been drawn from my own specimens under my direct personal supervision, and are accurate reproductions of the originals. The drawings and diagrams illustrating labor and its mechanism for the most part represent the woman on her back, thus affording a closer correspondence with the actual conditions encountered in practice. The representations of the various operative procedures have been redrawn from photographs taken from life.

Although no attempt has been made to present a complete bibliography, I have endeavored to give at the end of each chapter such references to the early history, as well as to the most recent advances in each subject, as to enable the student to refer readily to the most important original sources. In order to insure accuracy, the individual articles have been consulted in every case.

In conclusion, I desire to express my appreciation of the excellent work of Miss Katherine M. Montague and Mr. F. S. Lockwood in the preparation of the illustrations, and to thank my various assistants and my stenographer for most valuable aid. I am under very many obligations to my friend, Dr. Frank R. Smith, for the revision of the text and for many suggestions which have added materially to its clearness.





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| Spondylolisthesis, author's case of; fourth and fifth lumbar vertebræ . . . . .                               | 624     | 800  |
| front and back views of woman with . . . . .                                                                  | 625     | 801  |
| side view of woman with . . . . .                                                                             | 626     | 802  |
| vertical section through last three lumbar vertebræ and sacrum . . . . .                                      | 623     | 800  |
| Spontaneous evolution, mechanism of . . . . .                                                                 | 645     | 825  |
| Denman's mechanism . . . . .                                                                                  | 646     | 826  |
| Superior strait, reniform, engagement of head in . . . . .                                                    | 569     | 746  |
| showing passage of after-coming head . . . . .                                                                | 570     | 747  |
| Transverse presentation, frozen section through woman dying in labor . . . . .                                |         |      |
| through neglect . . . . .                                                                                     | 644     | 824  |
| Uterus, inversion of, complete . . . . .                                                                      | 656     | 848  |
| rupture of, longitudinal section through woman dying from . . . . .                                           | 658     | 860  |
| Walcher's hanging position . . . . .                                                                          | 577     | 758  |

## PATHOLOGY OF THE PUERPERIUM

|                                                                                                                    | FIG. | PAGE |
|--------------------------------------------------------------------------------------------------------------------|------|------|
| Colon bacillus endometritis; leukocytic wall not invaded by bacteria . . . . .                                     | 665  | 889  |
| Little's tube for obtaining uterine lochia . . . . .                                                               | 668  | 907  |
| Puerperal endometritis due to colon infection, showing marked development of leukocytic wall . . . . .             | 663  | 888  |
| Puerperal endometritis due to streptococcus infection, showing slight development of leukocytic wall . . . . .     | 664  | 888  |
| Streptococcus endometritis, showing invasion of leukocytic wall . . . . .                                          | 666  | 889  |
| Thrombosed pelvic vein, showing streptococci . . . . .                                                             | 667  | 891  |
| Uterus from woman dying ten days after labor from a mixed infection with streptococcus and bacillus coli . . . . . | 661  | 886  |
| from woman dying ten days after labor from streptococcus infection . . . . .                                       | 662  | 887  |

# OBSTETRICS

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## SECTION I

### ANATOMY

#### CHAPTER I

##### THE PELVIS

**Historical.**—As the mechanism of labor is essentially a process of accommodation between the fœtus and the passage through which it must pass, it is apparent that obstetrics lacked a scientific foundation until the anatomy of the bony pelvis and of the soft parts connected with it was clearly understood.

We are indebted to Andreas Vesalius (1543) for the first accurate description of the pelvis. Prior to the publication of his observations it had generally been believed that the birth of the child could not be effected until the pelvic cavity had become increased in size by the separation and gaping of the pelvic bones. Vesalius demonstrated the fallacy of this conception, and showed that the pelvis, for practical purposes, should be considered as an unyielding bony ring. His work was still further elaborated by his successor at the University of Padua, Realduo Columbus, who also demonstrated that each innominate bone was originally composed of three separate portions: the ilium, ischium, and pubis, which fused together just before the age of puberty. Julius Cæsar Arantius, Professor of Anatomy in Bologna (1559), also made important contributions to the subject, and was the first to recognize the existence of contracted pelves.

That the teachings of these three great anatomists did not exert so great an influence as might have been expected was largely due to the fact that no less an authority than Ambroise Paré still continued to adhere to the doctrine of the separation of the pubic bones during labor, and promulgated it in his obstetrical writings.

Among obstetricians, Heinrich van Deventer was the first to make a thorough study of the anatomy of the pelvis. In his *New Light for Midwives* (1701) he dwelt upon it in detail, and also described the main varieties of contracted pelves. At that time he felt called upon to apologize for taking up what was apparently so useless a consideration.

Smellie was the first English authority to devote particular attention to the subject. In his work on midwifery, published in 1752, he gave a most accurate description of the pelvis and its various measurements, and

also introduced the method of determining the antero-posterior diameter which we still employ. A few years previously (1735), Johann Huwé had gone over somewhat the same ground, but his work had not received anything like the consideration which was accorded to Smellie's investigations.

Almost simultaneously with Smellie, Levret, the great French obstetrician, published the results of his observations, and was one of the first to promulgate the conception of the axis and the planes of the pelvis. The value of his work, however, was considerably impaired by many inaccuracies. Among the Germans, Stein the younger was apparently the first to give a thoroughly accurate description of the pelvis, and since his time correct ideas upon the subject have gradually become popularized. Practically, therefore, an attempt to follow the further development of our knowledge concerning the pelvis would resolve itself into writing a history of obstetrics. To do this would go far beyond the scope of the present work; and let it here suffice to say that among the more modern authors Naegele, Luschka, Michaelis, Litzmann, and Breus and Kolisko in Germany, and Hodge in this country deserve particular mention.

**General Considerations.**—In both sexes the pelvis forms the bony ring through which the body weight is transmitted to the lower extremities, but



FIG. 1.—NORMAL FEMALE PELVIS.  $\times \frac{1}{3}$ .

in the female it assumes a peculiar form which adapts it to the purposes of childbearing.

It is composed of four bones: the sacrum, the coccyx, and two innominate bones, the last two being united by strong articulations with the sacrum at the sacro-iliac synchondroses, and with one another at the symphysis pubis. The purely anatomical characteristics of the pelvis are dealt with at length in the standard works on anatomy, so that we shall limit our considerations to the peculiarities of the female pelvis which are of importance in childbearing.



**The Pelvis from an Obstetrical Point of View.**—The *linea terminalis* forms the boundary between the false and the true pelvis, the former lying above and the latter below it. The *false pelvis* is bounded posteriorly by the lumbar vertebræ and laterally by the iliac fossæ, while in front the boundary is formed by the lower portion of the anterior abdominal wall. It possesses no particular obstetrical significance, but serves to support the intestines in the non-pregnant woman, and the enlarged uterus in the pregnant condition. It varies considerably in size in different individuals, according to the flare of the iliac bones; but ordinarily in dried specimens the distances between the anterior superior spines of the ilium and between the most widely distant portions of the iliac crests measure 23 and 26 centimeters respectively.

The *true pelvis* lies beneath the *linea terminalis*, and is the portion concerned in childbearing. It is bounded above by the promontory and alæ of the sacrum, the *linea terminalis*, and the upper margins of the pubic bones, and below by the pelvic outlet. Its cavity, roughly speaking, may be compared to an obliquely truncated cylinder with its greatest height posteriorly, since its anterior wall at the symphysis pubis measures  $4\frac{1}{2}$  to 5 centimeters, and its posterior wall 10 centimeters. With the woman in the upright position, in its upper portion the pelvic canal is directed downward and backward, while in its lower course it curves and becomes directed downward and forward.

The walls of the true pelvis are partly bony and partly ligamentous. Its posterior boundary is furnished by the anterior surface of the sacrum, its lateral limits are formed by the sacro-sciatic notches and ligaments, and by the inner surface of the ischial bones; while in front it is bounded by the obturator foramina, the pubic bones, and the ascending rami of the ischial bones.

The only part of the lateral wall of the pelvis which is entirely bony is made up of the body of the ischium and part of the ilium, the inner surface of which, with the woman in the upright position, forms an inclined plane which is directed from above downward and inward, and from behind forward. Considerable importance was attached to these surfaces by Hodge, who designated them as the *inclined planes* of the pelvis, and considered that they exercised a good deal of influence in causing internal rotation of the head during labor. This view, however, has since been abandoned. If the planes of the ischial bones were extended downward they would meet somewhere about the region of the knee. Extending from the middle of the posterior margin of each ischium are the ischial spines, which are of no little obstetrical importance, inasmuch as a line drawn between them represents the shortest diameter of the pelvic cavity. Moreover, since they can be readily felt on vaginal examination, they can be made to serve as valuable landmarks in determining the extent to which the presenting part had descended into the pelvis.

The sacrum forms the posterior wall of the pelvic cavity. Its upper anterior margin, corresponding to the body of the first sacral vertebra, and designated as the promontory, can be felt on vaginal examination, and offers a landmark which serves as the basis of internal pelvimetry. Nor-



mally, the sacrum presents a marked vertical and a less pronounced lateral concavity, which, in abnormal pelves, may undergo variations. A straight



FIG. 2.—DRAWING SHOWING THAT THE SACRUM IS NOT THE KEYSTONE OF THE ARCH.

Modified from Duncan.  $\times \frac{1}{2}$ .

fluence of the body weight were it not held in position by the strong posterior ilio-sacral ligaments (Fig. 2).

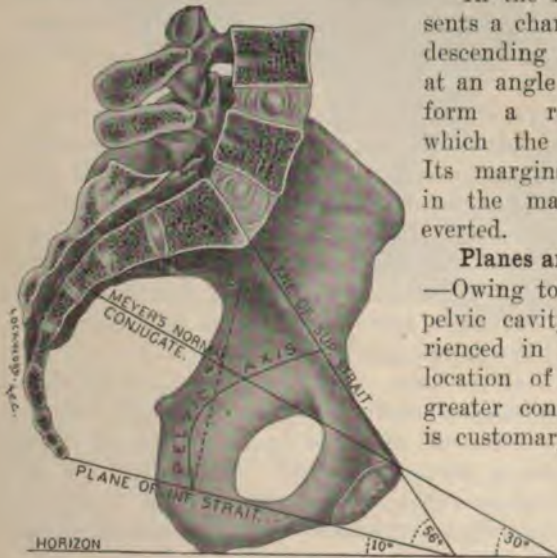


FIG. 3.—SAGITTAL SECTION THROUGH NORMAL PELVIS.  $\times \frac{1}{2}$ .

superior strait; (2) the plane of greatest, and (4) the plane of least, pelvic dimensions (Figs. 3 and 5).

The superior strait represents the upper boundary of the cavity, and

line drawn from the promontory to the tip of the sacrum usually measures 10 centimeters, whereas if the concavity be followed the distance averages 12 centimeters. The sacrum was formerly regarded as the "keystone" of the pelvic arch, but Matthews Duncan showed that this conception was erroneous, and that it represents an inverted keystone, inasmuch as it is wider along its anterior than along its posterior surface, so that it would tend to slip downward and forward into the pelvic cavity under the in-

In the female the pubic arch presents a characteristic appearance. The descending rami of the pubis unite at an angle of 90 to 100 degrees, and form a rounded opening through which the head can readily pass. Its margins are more delicate than in the male, and are considerably everted.

#### Planes and Diameters of the Pelvis.

—Owing to the peculiar shape of the pelvic cavity and the difficulty experienced in rendering clear the exact location of a body occupying it, for greater convenience in description it is customary to construct certain imaginary planes through it. Those most frequently employed are designated as (1) the

superior strait; (2) the inferior strait; (3) the

is frequently spoken of as the pelvic inlet. It is somewhat oval in shape, with a depression on its posterior border corresponding to the promontory of the sacrum, and is sometimes described as blunt heart-shaped. It is bounded posteriorly by the promontory and alae of the sacrum; laterally by the linea terminalis; anteriorly by the horizontal rami of the pubic bones and the upper margin of the symphysis pubis. Strictly speaking, it is not a mathematical plane, since its lateral margins, as represented by the linea terminalis, are at a lower level than its central portion between the promontory and symphysis.



FIG. 4.—NORMAL FEMALE PELVIS SHOWING DIAMETERS OF THE SUPERIOR STRAIT.  $\times \frac{1}{2}$ .

Four diameters are usually described as traversing the superior strait: the antero-posterior, the transverse, and two oblique diameters. The antero-posterior diameter extends from the middle of the promontory of the sacrum to the upper margin of the symphysis pubis, and is designated as the *conjugata vera* or *true conjugate*. This term was first employed by Roederer, who likened the superior strait to an ellipse, whose shorter diameter ran antero-posteriorly. Normally, the conjugata vera measures 11 centimeters, but it may become markedly shortened in abnormal pelves. From a practical point of view it is the most important diameter, inasmuch as it is the point of departure for all attempts to estimate the size of the pelvis in actual practice. The transverse diameter is constructed at right angles to the conjugata vera, and represents the greatest distance between the linea terminalis on either side; it usually intersects the conjugata vera at a point a short distance in front of the promontory. Normally it measures 13.5 centimeters. Each of the oblique diameters extends from one of the sacro-iliac synchondroses to the ilio-pectineal eminence on the opposite side of the pelvis. They measure 12.75 centimeters, and are designated as right and left respectively, according as the starting-point is the right or left sacro-iliac synchondrosis. Instead of employing the terms right and left, the Germans usually speak of the first and second oblique diam-

eters. The sacro-cotyloid diameters are sometimes described; they extend from the middle of the promontory of the sacrum to the ilio-pectineal eminence on either side, and measure from 8.75 to 9 centimeters. Normally these two diameters are of equal length, but in certain forms of contracted pelvis they may present marked variations.

The antero-posterior diameter of the superior strait, or *conjugata vera*, is also designated as the *anatomical conjugate*. This does not represent the shortest distance between the promontory of the sacrum and symphysis pubis, which is along a line drawn from the former to a point on the inner surface of the symphysis a few millimeters below its upper margin. The latter is the shortest diameter through which the head must pass in descending into the superior strait, and was designated by Michælis as the *obstetrical conjugate*. It is a few millimeters shorter than the anatomical or true conjugate, but for practical purposes the distinction is rarely made, and the obstetrician simply speaks of the *conjugata vera*.

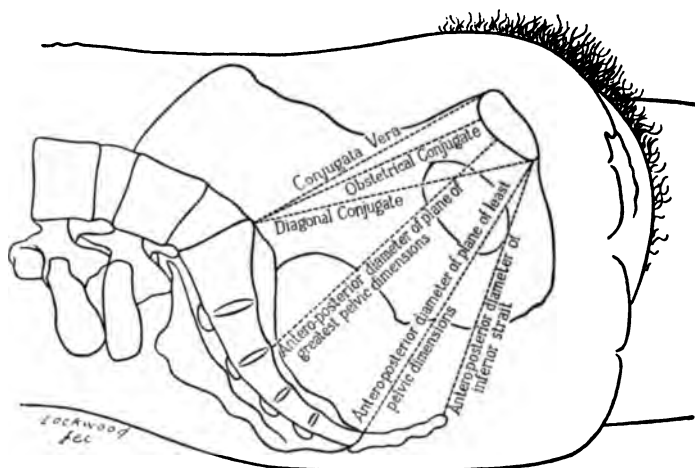


FIG. 5.—DIAGRAM SHOWING PELVIC PLANES.  $\times \frac{1}{2}$ .

Unfortunately, in the living woman, the *conjugata vera* can not be measured directly with the examining finger, and various more or less complicated instruments have been devised for its determination, none of which gives perfectly satisfactory results. For clinical purposes, therefore, we are content to estimate its length indirectly, by measuring the distance from the lower margin of the symphysis to the promontory of the sacrum, and subtracting from the result 1.5 to 2 centimeters, according to the height and inclination of the symphysis pubis. This diameter is the *conjugata diagonalis* or *oblique conjugate*, the importance of which was first emphasized by Smellie.

The outlet of the pelvis is designated the inferior strait. It is not a plane in a mathematical sense, but consists of two triangular planes whose bases would meet on a line drawn between the two ischial tuberosities. It is bounded posteriorly by the tip of the coccyx, laterally by the



greater sacro-sciatic ligaments and the ischial tuberosities, and anteriorly by the lower margin of the pubic arch (Fig. 6). For the pelvic outlet two diameters are described: the antero-posterior and the transverse. The



FIG. 6.—PELVIC OUTLET.  $\times \frac{1}{3}$ .

former extends from the lower margin of the symphysis pubis to the tip of the coccyx, and the latter between the inner margins of the ischial tuberosities. With the coccyx in its normal position, the antero-posterior diameter measures 9.5 centimeters, which is increased to 11.5 centimeters during labor by the backward displacement of the tip of the coccyx. The transverse diameter measures 11 centimeters.

The plane of greatest pelvic dimensions was first described by Levret,

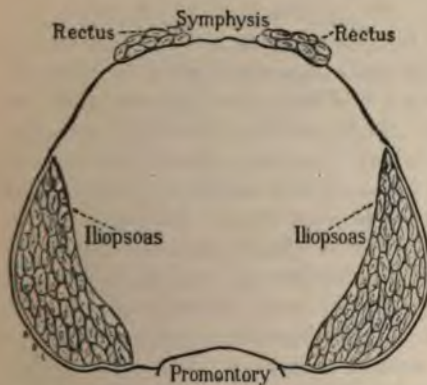


FIG. 7.—SUPERIOR STRAIT (Veit).



FIG. 8.—PLANE OF GREATEST DIMENSIONS.

and, as its name implies, represents the roomiest portion of the pelvic cavity. It extends from the middle of the posterior surface of the symphysis pubis to the junction of the second and third sacral vertebrae, and laterally passes through the ischial bones over the middle of the ace-

tabulum. Its antero-posterior and transverse diameters measure 12.75 and 12.5 centimeters, respectively. Since its oblique diameters terminate in the obturator foramina and the sacro-sciatic notches, they are subject to marked variations in length.

The plane of least pelvic dimensions extends through the lower margin of the symphysis pubis, the tip of the sacrum, and the ischial spines. Its antero-posterior diameter measures 11.5 cm. Its transverse diameter extends between the ischial spines and measures 10.5 centimeters, being the shortest diameter in the normal pelvic cavity.

In order to facilitate the study of the pelvic cavity, Hodge constructed four parallel planes, the first of which is the superior strait, while the other three are parallel to it and pass through the lower margin of the symphysis

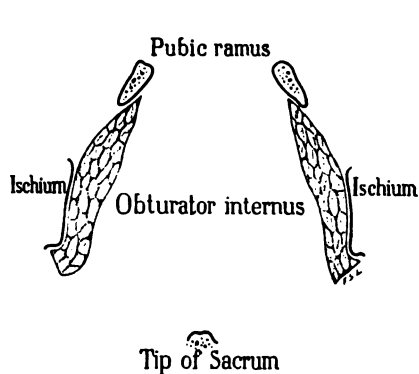


FIG. 9.—PLANE OF LEAST DIMENSIONS (Veit).

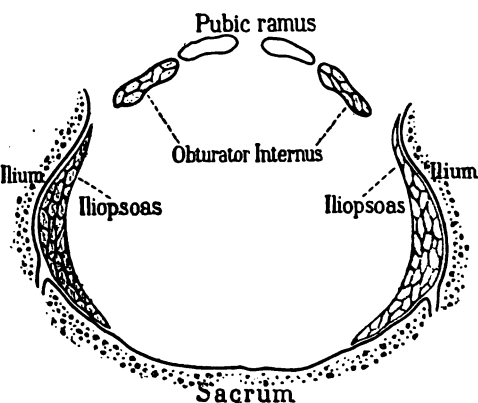


FIG. 10.—VEIT'S MAIN PLANE.

pubis, the ischial spines, and the tip of the coccyx respectively. The second parallel practically corresponds to the plane of greatest pelvic dimensions, and is very closely related to that described by Veit as the main plane of the pelvis, which extends from the lower margin of the symphysis pubis to the junction of the first and second sacral vertebrae. According to Veit this, from an obstetrical standpoint, is the largest plane of the pelvis, inasmuch as it is not encroached upon by the pelvic soft parts, but passes above the obturator and pyriformis and below the ilio-psoas muscles.

Most pelves present slight individual variations in size, and perfectly normal and symmetrical examples are rarely seen. The measurements which we have given are those of Schroeder, and are the averages obtained from the accurate mensuration of 50 normal pelves.

**Pelvic Inclination.**—The normal position of the pelvis, with the woman in the erect posture, can be reproduced by holding the specimen in such a way that the incisions of the acetabula look directly downward. According to Meyer, the pelvis is in its normal position when the anterior-superior spines of the ilium and the pubic spines are in the same vertical plane. Under these conditions the promontory of the sacrum is 9.5 to 10 centimeters higher than the upper margin of the symphysis pubis.

By the term *pelvic inclination* is understood the angle which the plane of the superior strait forms with the horizon (see Fig. 3). This conception was first introduced by J. J. Müller and Roederer, and the early statements concerning it were very conflicting. According to Meyer, the center of gravity of the body passes along an imaginary vertical plane just posterior to the acetabula, so that under the influence of the body weight the pelvis would tend to rotate backward, were it not held in position by the strong ilio-femoral ligaments. It is therefore apparent that the pelvic inclination must vary according to the degree of tension of these structures; it will be diminished when they are relaxed, and *vice versa*. It is least marked when the legs are slightly rotated inward and spread a little apart, and greatly increased when the knees are pressed tightly together, or when the legs are widely spread apart or rotated strongly either inward or outward. With the woman in the upright position the pelvic inclination is usually estimated at 45 to 50 degrees, but may vary from 40 to 100 degrees, according to the degree of tension exerted by the ilio-femoral ligaments. In certain diseased conditions it may be obliterated, when the plane of the superior strait may become parallel to, or even form an obtuse angle with, the horizon.

The first accurate work upon this subject was done by Naegele, who measured the distance from the floor to the lower margin of the symphysis pubis and the tip of the sacrum respectively, and in this way estimated the inclination which the inferior strait formed with the horizon. He then placed a normal pelvis in a similar position and estimated the inclination of its superior strait, which was usually about 60 degrees.

In view of the marked variations to which the pelvic inclination is subject, Meyer introduced a new conception concerning it, and stated that it was considerably influenced by the extent to which the sacrum rotated about its transverse axis. As this passes through the center of the body of the third sacral vertebra, it is apparent that this portion of the sacrum retains approximately the same position, no matter to what extent its upper or lower portions may be displaced. Meyer, therefore, constructed a diameter extending from the upper margin of the symphysis to the middle of the third sacral vertebra, and designated it the *normal conjugate*. Its inclination he estimated at 30 degrees, and stated that it remained practically constant in all positions of the body.

Except when markedly abnormal, the pelvic inclination possesses no practical obstetrical significance, and is of value only in the study of atypical pelves and in anthropology. Several complicated instruments have been invented for determining it. In 1900, Neumann and Ehrenfest devised a comparatively simple instrument for determining the inclination of the external conjugate, which for practical purposes gives a fair idea of the degree of pelvic inclination.

Since the lower margin of the symphysis occupies a lower level than the tip of the sacrum, the plane of the inferior strait is also inclined to the horizon, forming an acute angle, which is usually estimated at 10 degrees. Much more important, however, is the angle which is formed between the posterior surface of the symphysis pubis and the conjugata vera;

this is usually estimated at 90 to 100 degrees, but varies considerably according to the shape, height, and inclination of the former. This must always be taken into consideration in estimating the length of the conjugata vera from that of the conjugata diagonalis, since it is evident that the amount to be subtracted from the latter will vary with the size of the angle in question.

✓ **The Pelvic Axis.**—Deventer in 1701 introduced the conception of a pelvic axis. Since then numerous methods for its construction have been described, the most usual being a line drawn through the centers of innumerable planes extending from the symphysis to the sacrum, thus giving a graceful curve (see Fig. 3). This was formerly believed to represent the course which the child pursued in its passage through the pelvis, but the work of Naegele, Hegar, Pinard, and others has shown that such is not the case, and that an axis so constructed possesses only an historical interest.

At the end of pregnancy the axis of the superior strait, if extended directly upward, would pass through the abdominal wall at about the region of the umbilicus, while the axis of the inferior strait would impinge upon the promontory of the sacrum. As the pelvic canal is practically cylindrical in shape down to the plane of greatest pelvic dimensions, it is apparent that the head must descend along the downward prolongation of the axis of

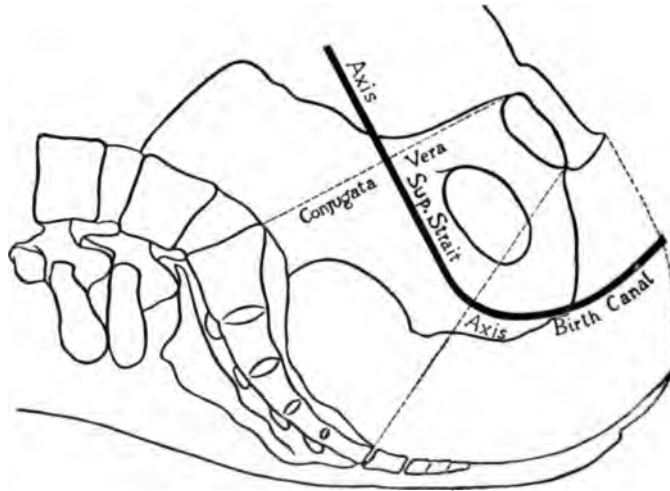


FIG. 11.—DIAGRAM SHOWING PELVIC AXIS.  $\times \frac{1}{2}$ .

the superior strait until it has nearly reached the level of the ischial spines, and only begins to curve forward in the region of the inferior strait. Therefore the obstetrical pelvic axis should be represented as straight in its upper and curved only in its lower portion (see Fig. 11), as was well understood by Hodge, and strongly insisted upon by Sellheim.

**The Pelvic Joints.**—Anteriorly the pelvic bones are held together by the symphysis pubis, which consists of a mass of fibro-cartilage, and by



the superior and inferior pubic ligaments, the latter being frequently designated as the *ligamentum arcuatum pubis*. Luschka demonstrated the presence of a synovial cavity in the fibro-cartilage, and therefore classed the symphysis among the true joints (Fig. 12). Joessel, on the other hand, denies its existence, and states that the fluid in the interior of the symphysis is simply a product of degeneration. Whether it be a true joint or not, in any case the symphysis admits of a certain amount of motility, which becomes particularly marked during pregnancy. This fact was demonstrated by Budin, who showed that if the finger were inserted into the vagina of a pregnant woman, and she were made to walk, one could distinctly feel the ends of the pubic bones move up and down with each step.



FIG. 12.—FRONTAL SECTION SYMPHYSIS PUBIS (Spalteholz).  $\times 1$ .

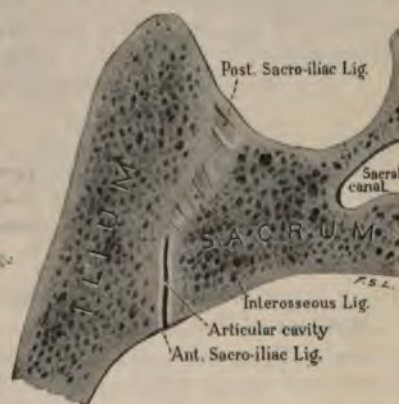


FIG. 13.—SACROILIAC SYNCHONDROSIS (Spalteholz).  $\times 1$ .

The articulations between the sacrum and innominate bones were formerly described as synchondroses, but Luschka conclusively demonstrated the presence of a synovial cavity within them, and therefore classed them among the true joints (Fig. 13). These articulations possess a certain amount of motility, which plays a not unimportant part in practical obstetrics.

Walcher, in 1889, stated that the diagonal conjugate varied about 1 centimeter in length, according as it was measured with the woman in the usual obstetrical position, or with her buttocks resting on the edge of the table and her legs hanging down without any support, which has since been known as the Walcher or hanging position. His observations have been confirmed by nearly all who have repeated his work, among whom may be mentioned Klein, Wehle and Leopold, and Küttner. The subject was chosen as one of the main themes for discussion at the International Gynecological and Obstetrical Congress held at Amsterdam in 1899. The speakers, almost without exception, admitted the general correctness of Walcher's statements, differing only as to the extent of the changes, while Bar was the only one to deny their occurrence.

This slight amount of motility is utilized in dealing with contracted



pelves; and not infrequently the increase in the size of the conjugata vera brought about by Walcher's position has proved sufficient to permit the engagement of the presenting part, which otherwise could not occur. The effect of Walcher's position upon the size of the pelvic cavity was

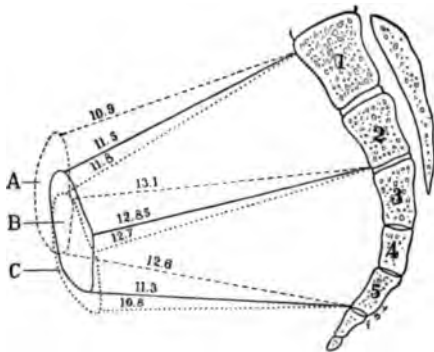


FIG. 14.—DIAGRAM SHOWING VARIATION OF ANTERO-POSTERIOR DIAMETER OF PELVIS IN VARIOUS POSITIONS (Küttner).  $\times \frac{1}{2}$ .  
A, lithotomy; B, horizontal; C, Walcher's position.

studied very carefully by Küttner in 1898, who showed in three cases that the conjugata vera was respectively 1.4, 0.9, and 1 centimeter longer when measured in the hanging than in the lithotomy position. Fig. 14 gives a graphic illustration of the changes in shape in one of these pelves. Furthermore, rotation of the innominate bones upon the sacrum causes changes in the antero-posterior diameter of the inferior strait. In the Walcher position it is shortened, whereas it is lengthened when the legs are sharply flexed over the body. In 1911, I showed that it could be increased by from

1 to 2.5 centimeters by placing the woman in an exaggerated Sims position.

**Methods of Comparing Pelves.**—Inasmuch as the normal pelvis usually presents slight individual variations in its form and dimensions, and as contracted pelves differ markedly from one another in shape, several devices have been employed to enable us readily to compare their points of difference. The decimal method, suggested by Litzmann, is very satisfactory for most purposes. In it the various diameters are expressed in terms of the conjugata vera, which is reckoned as 100.

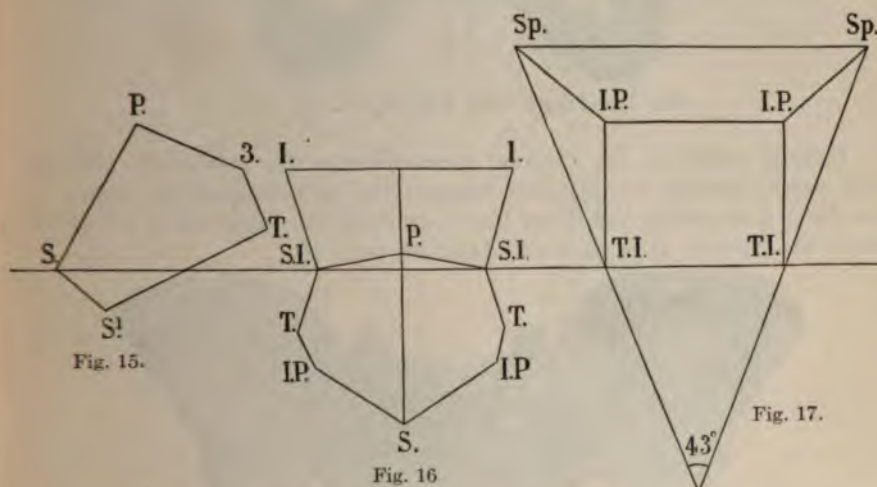
| COMPARISON OF VARIOUS DIAMETERS OF NORMAL PELVES BY LITZMANN'S DECIMAL METHOD. | DIAMETERS.        |             |          |
|--------------------------------------------------------------------------------|-------------------|-------------|----------|
|                                                                                | Antero-posterior. | Transverse. | Oblique. |
| Superior strait.....                                                           | 100               | 122.7       | 113      |
| Plane of greatest pelvic dimension.....                                        | 115               | 113.6       |          |
| Plane of least pelvic dimension.....                                           | 105.5             | 95.5        |          |
| Inferior strait.....                                                           | 105.5             | 100         |          |

Breisky introduced a graphic method for comparing pelves and constructed three diagrams, representing a vertical mesial section of the pelvis, the plane of the superior strait, and a frontal view of the pelvis. The first is constructed upon Meyer's normal conjugate, the second upon the distance between the sacro-iliac synchondroses, and the third upon the transverse diameter of the pelvic outlet (Figs. 15-17).

**Individual Variations in the Pelvis.**—With the exception of the skull, no portion of the skeleton presents greater individual variations than the

pelvis. This is due partly to the fact that it is developed from a considerable number of bones, and partly to the varying mechanical and developmental influences to which it is subjected during the early years of life. Indeed, we may say that no two pelves are exactly alike, and that perfectly normal pelves are rarely seen; so that an accurate conception of the form and dimensions of what may be termed the normal type can be obtained only from averages based upon the examination of numerous approximately normal pelves.

Owing to the greater employment of the right half of the body, the corresponding side of the pelvis is more developed than the left. Individual variations may be observed in the form, consistence, and general character of the pelvic bones, in the angles which the iliac fossæ form with the walls of the pelvic basin, in the shape of the sacrum, and particularly in that of the cavity itself. In view, therefore, of the varying thickness of the pelvic bones, and especially of the degree of flaring of the ilia, accurate conclusions cannot be drawn from external pelvimetry alone.



FIGS. 15-17.—BREISKY'S DIAGRAMS FOR COMPARING PELVES.

*I.*, inclination of iliac bones; *I. P.*, ilio-pectineal eminence; *P.*, promontory of sacrum; *S.*, upper margin of symphysis; *S.*, lower margin of symphysis; *S. I.*, sacro-iliac synchondrosis; *Sp.*, iliac spines; *T.*, transverse diameter, superior strait; *T. I.*, tuber ischii; *3*, bend in body of third sacral vertebra.

**Sexual Differences in the Adult Pelvis.**—The pelvis presents marked sexual differences. Speaking generally, we may say that in the male the pelvis is heavier, higher, less graceful, and presents a more conical appearance than in the female. In the former the muscular attachments are much more strongly marked, and the iliac bones are less flared than in the latter. The pubic arch is more angular in shape, and presents an aperture of 70 to 75 degrees, as compared to 90 to 100 degrees in the female. This difference is so marked that one usually speaks of the pubic angle in the male and the pubic arch in the female. In the male pelvis the

superior strait is smaller and more triangular in outline, while the pelvic cavity is deeper and more conical in shape. These differences are readily noted in Figs. 18, 19, and 20, and may be especially emphasized by a comparison of the various measurements in the two sexes.



FIG. 18.—FRONT VIEW FEMALE PELVIS.  $\times \frac{1}{2}$ .

Broadly speaking, the external measurements are practically alike in both sexes, though the distance between the anterior-superior spines of the ilium is somewhat less in the male; while all the diameters of the pelvic cavity are shorter, as is shown by table on page 16.



FIG. 19.—FRONT VIEW MALE PELVIS.  $\times \frac{1}{2}$ .

It is therefore apparent that the outlet of the male pelvis is contracted to such a degree as to render it very difficult for a living child to pass through it, particularly in being forced out under the pubic angle.

Occasionally the female pelvis may approach the male type, and in such circumstances may offer insuperable obstacles to the birth of the child, and necessitate radical operative procedures to effect delivery.

Numerous not very satisfactory attempts have been made to explain the cause of the differences between the male and female pelvis. According to Fehling and most subsequent investigators, sexual differences make

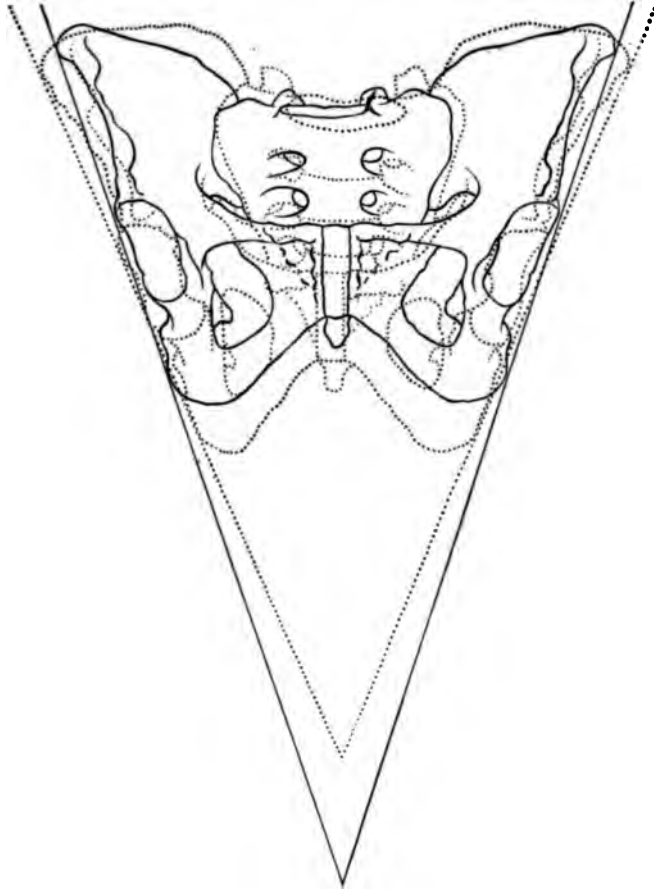


FIG. 20.—DIAGRAM SHOWING DIFFERENCE IN SHAPE OF MALE [...] AND FEMALE [—] PELVIS.

their appearance as early as the fourth or fifth month of intrauterine life, so that the sex can be ascertained long before term by examination of the pelvis. Arthur Thompson has made the same statement, and my own investigations have led me to similar conclusions. On the other hand, Schroeder and other authorities attribute the characteristic shape of the female pelvis to the presence of the internal genitalia, and state that the pelvis of female eunuchs, as well as those of individuals in whom the uterus is congenitally absent, conform to the male type. While the correctness

of such statements cannot be doubted, it nevertheless seems probable that the greater part of the sexual differences must be due to inherent development and hereditary factors.

| COMPARISON OF MALE AND FEMALE PELVIS. | DIAMETERS.        |             |           |
|---------------------------------------|-------------------|-------------|-----------|
|                                       | Antero-posterior. | Transverse. | Oblique.  |
| Superior strait:                      |                   |             |           |
| Male.....                             | 10.5              | 12.5        | 12 cm.    |
| Female.....                           | 11                | 13.5        | 12.75 cm. |
| Inferior strait:                      |                   |             |           |
| Male.....                             | 9.5               | 8 cm.       |           |
| Female.....                           | 11.5              | 11 cm.      |           |

**Racial Differences in Pelves.**—Considerable variations may be observed in the form of the pelvis in various races, and especially upon comparing those obtained from aboriginal and civilized peoples. But in spite of the researches of Weber, Stein, Verneau, Topinard, Turner, and others, our knowledge of the subject is still fragmentary. Stein distinguished four groups of pelves:

1. Blunt heart-shaped.
2. Elliptical, with the greatest diameter transverse.
3. Round.
4. Elliptical, with the greatest diameter antero-posterior.

Topinard attempted to classify pelves according to their "general index"—that is, the relation between their height and width, as represented by the distance between the iliac crests. His careful measurements showed that the pelvis becomes increasingly lower and broader, the more civilized the race from which it is obtained.

Turner based his classification upon the relation between the transverse and antero-posterior diameters of the superior strait, and divided pelves into three great groups: dolichopellic, in which the conjugata vera is greater than the transverse diameter; mesatipellic, in which the conjugata vera and transverse diameters are of equal length; and platypellic, in which the conjugata vera is shorter than the transverse diameter. He stated that the first variety had not been observed in women, though it is not infrequent in men; but the investigations of Scharlau show that Turner was in error, as it is frequently noted in the aboriginal women of Australia. The mesatipellic variety is observed in the women of the lower races, notably among the Bushmen, Hottentots, and the lower classes of negroes; while the platypellic forms are found in all the higher races. But even among civilized whites considerable racial differences are not infrequently noted, and it is generally stated that the pelves of the English and Holstein women are broader than those of other nationalities; while the Jewesses living in the vicinity of Dorpat have extremely small pelves. Gache states that the pelvis is usually normal in the Argentine Republic, while it is imperfectly developed and frequently funnel-shaped in Mexico.

While the study of the racial differences in the pelvis presents a marked

anthropological interest, it is, as yet, of little practical obstetrical value, as no extended studies have been made concerning the form and size of the heads of children which are born through them. The careful work of my former assistant, T. F. Riggs, has shown that contracted pelves occur several times more frequently among black than white women in Baltimore (34 per cent. to 9 per cent.), while operative delivery is more frequently required among the latter. This is due to the fact that the negro children are somewhat smaller and have more compressible heads, and thus compensate for the smaller size of the pelvis.



FIG. 21.—SAGITTAL SECTION SHOWING RELATIVE PROPORTION OF BONE AND CARTILAGE IN THE PELVIS OF A NEWLY BORN CHILD.  $\times 1$ .

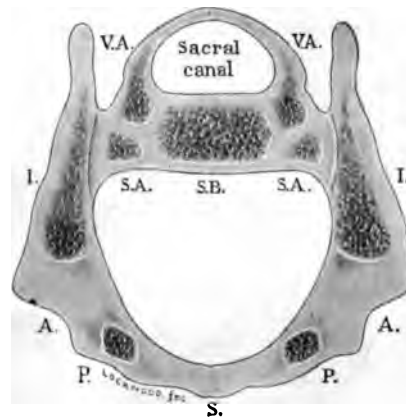


FIG. 22.—SECTION THROUGH INFANTILE PELVIS PARALLEL TO SUPERIOR STRAIT, SHOWING RELATIVE PROPORTIONS OF BONE AND CARTILAGE.  $\times 1$ .

A., acetabulum; I., ilium; P., pubic bone; S., symphysis pubis; S. A., ala of sacrum; S. B., body of sacrum; V. A., vertebral arch.

**Pelvis of the New-born Child.**—The pelvis of the child at birth is partly bony and partly cartilaginous. The innominate bone does not exist as such, its place being taken by the ilium, ischium, and pubis, which are united by a large Y-shaped cartilage, the three bones meeting in the acetabulum. The iliac crests and the acetabula, as well as the greater part of the ischio-pubic rami, are entirely cartilaginous in structure. Figs. 21 and 22 clearly show the extent to which the infantile pelvis is ossified.

The cartilaginous portions of the pelvis gradually give place to bone, but complete union in the neighborhood of the acetabulum does not occur until about the age of puberty, and occasionally even at a later period. Indeed, we may say that the innominate bones do not become completely ossified and fully developed until between the twentieth and twenty-fifth years.

Each innominate bone is developed from 12 centers of ossification.



Three of these are primary and give rise to the ilium, ischium, and pubis. They make their appearance by the end of the first half of pregnancy. The remaining 9 centers—the so-called epiphyseal centers—are secondary, and do not develop until a considerably later period, some of them not until after the age of puberty.

The sacrum at birth is likewise partly bony and partly cartilaginous. It is made up of 21 distinct bones, each of which is derived from a single center of ossification. The 21 centers are arranged as follows: 1 for each vertebral body (5); 3 for the alæ on either side (6); and 2 for the arches of each vertebra (10). To these must be added the various epiphyseal centers which appear later. The cartilage gradually becomes ossified, and the various component parts of the sacrum fuse together. The alæ are the first portions to become united, after which the vertebral bodies gradually become welded together, the fusion extending from below upward. According to Litzmann, the bodies of the sacral vertebrae are not entirely united until the seventh year, and complete ossification of the sacrum is not effected until the twenty-fifth year. Fig. 23 represents the disarticulated pelvis of a child three years old, and clearly shows the extent to which ossification has progressed at that age.



FIG. 23.—DISARTICULATED PELVIS OF THREE-YEAR-OLD GIRL.  $\times \frac{1}{2}$ .



FIG. 24.—SAGITTAL SECTION THROUGH PELVIS OF FIVE-YEAR-OLD GIRL.  $\times \frac{1}{2}$ .

The pelvis of the new-born child differs from that of the adult not only in being made up of a large number of bones, which are united by cartilage, but more particularly in its characteristic shape. This is clearly seen upon comparing Figs. 25 and 26, which represent vertical mesial sections through the trunk of a new-born child and of an adult woman. In the former the vertebral column is almost vertical, and its lumbar curvature practically absent. The promontory is very slightly marked, and is situated at a much higher level than in the adult. The sacrum is almost straight from above downward, but presents a more marked transverse concavity than in the adult. Its alæ are only slightly developed, and as a consequence the pelvis is relatively narrower. The iliac fossæ are almost vertical, and the horizontal rami of the pubis are far shorter than in the adult. The pubic arch is much more angular, while the pelvic inclination is decidedly greater. The superior strait is narrower and more angular in shape, the relation between the conjugata vera and the transverse diameter being 100 to 105,

instead of 100 to 122.5, as in the normal adult pelvis. The cavity of the pelvis is relatively much smaller, and is distinctly funnel-shaped. The antero-posterior and transverse diameters of the pelvic outlet, when expressed in terms of the conjugata vera, are respectively 93 and 73, instead of 104.5 and 100 as in the adult.

As we have already indicated, sexual differences make their appearance at a very early period. Fehling showed that they could be detected as early as the fourth month, when he found that the first sacral vertebra was wedge-shaped in the female, instead of cuboidal as in the male. His results have since been confirmed by a number of observers, among whom Balandin, Jürgens, and Arthur Thompson may be mentioned; my own work also corroborates their statements.



FIG. 25.—SAGITTAL SECTION THROUGH BODY OF NEWLY BORN CHILD.



FIG. 26.—SAGITTAL SECTION THROUGH ADULT WOMAN (KELLY), REDUCED TO THE SAME SIZE AS FIG. 25 FOR COMPARISON.

The pelvis of the female fœtus or new-born child presents the following characteristics as compared with that of the male: The pelvic canal is less funnel-shaped, the pubic arch is wider, the sacro-sciatic notches are larger, and the lumbar region of the spinal column is more markedly curved.

**Transformation of Fœtal into Adult Pelvis.**—The mechanism by which the pelvis of the fœtus is converted into the adult form is of interest, not only from a scientific, but also from a practical, point of view, as it affords important information concerning the mode of production of certain varieties of deformed pelves.



The earliest investigations upon this subject were made by De Frémery and Denman, who were followed by Litzmann, Duncan, Fehling, Schroeder, Veit, Von Meyer, and others. At present it is generally believed that in the evolution of the form of the pelvis two sets of factors—developmental and inherent tendencies, and mechanical influences—are concerned. That the process is not entirely the result of the action of mechanical forces is manifested by the existence of sexual and racial differences in the adult pelvis, but especially by the presence of the former in the foetal pelvis, long before it has been subjected to the usual mechanical influences. Moreover, the mechanical influences which come into play after birth are identical in both sexes, but despite this fact the sexual differences become still more accentuated as puberty is approached.

The part played by developmental and hereditary influences was clearly demonstrated by Litzmann, who showed that the female sacrum was characterized by a marked increase in width as compared with that of the male. At birth, in both sexes, the body of the first sacral vertebrae is twice as broad as the alae (100 to 50), but in the adult the relation becomes 100 to 76 in the female, and 100 to 56 in the male, indicating a much more rapid growth of the alae in the former. Falk, in 1908, held that all the changes in the developing pelvis are due to similar causes, and that the influence of the various mechanical factors is merely accessory.

The effect exerted by mechanical influences has been particularly studied by Duncan, Meyer, Veit, and Schroeder, while Kehrner has insisted upon the part played by muscular action. According to Schroeder, three mechanical forces take part in bringing about the final shape of the pelvis—namely, the body weight, the upward and inward pressure exerted by the heads of the femora, and the cohesive force exerted at the symphysis pubis.

So long as the child remains constantly in the recumbent position these forces are in abeyance, but as soon as it sits up or walks the body weight is transmitted through the vertebral column to the sacrum, and, as the center of gravity is anterior to its promontory, the force transmitted is resolved into two components, one of which is directed downward and the other forward. Accordingly, the two together tend to force the promontory of the sacrum downward and forward toward the symphysis pubis, a process which can only be accomplished by the sacrum rotating slightly about its transverse axis so that its tip tends to become displaced upward and backward. This displacement, however, is limited, as it is resisted by the strong sacro-sciatic ligaments which permit of only slight extension, with the result that the partly cartilaginous sacrum becomes bent upon itself just in front of its axis—*i. e.*, about the middle of its third vertebra—so that its anterior surface becomes markedly concave from above downward, instead of flat as it was previously. At the same time the body weight forces the bodies of the sacral vertebrae forward, so that they project slightly beyond the alae and thus tend to diminish the transverse cavity of the sacrum.

As the anterior surface of the sacrum is wider than its posterior, the bone tends to sink down into the pelvic cavity under the influence of the

body weight, and would prolapse completely into it were it not held in place by the strong posterior ilio-sacral ligaments which suspend it, so to speak, from the posterior-superior spines of the ilium. Accordingly, as the sacrum is pushed downward into the pelvic cavity it exerts marked traction upon these ligaments, which in turn drag the posterior-superior spines inward toward the middle line, and consequently tend to rotate the anterior portions of the innominate bones outward. Excessive outward rotation is prevented, however, by the cohesive force exerted at the symphysis, but particularly by the upward and inward pressure exerted by the heads of the femora. Practically, then, the iliac bone becomes converted into a two-armed lever, with the articular surface of the sacrum as a fulcrum; as a consequence, it bends at its point of least resistance, which is just anterior to the articulation, and thus gives the pelvis a greater transverse and a lesser antero-posterior diameter (Figs. 27, 28). At the



Fig. 27.



Fig. 28.

FIGS. 27, 28.—DIAGRAMMATIC REPRESENTATIONS OF SECTIONS THROUGH THE INFANTILE AND ADULT PELVIS (Schroeder).

same time it must be remembered that a considerable part of the transverse widening is more apparent than real, and is due to the relative shortening of the conjugata vera by the downward and forward displacement of the promontory of the sacrum.

It is apparent that the forces just mentioned must act in identically the same manner in the two sexes, so that, while they may serve to explain many points in the transformation of the foetal into the adult pelvis, they fail to give a satisfactory explanation of its sexual differences, and we are therefore compelled to agree with Falk, Fehling, Freund, Joessel, and Breus and Kolisko that the latter must owe their origin to certain congenital tendencies concerning whose nature we are as yet absolutely ignorant.

Breus and Kolisko insist that too great stress has been laid upon the action of mechanical forces in the production of the ultimate shape of the pelvis, and hold that the relative flattening of the superior strait is due not so much to the downward and forward displacement of the base of the sacrum as to the unequal rate of growth before puberty of



the sacrum and the several component parts of the innominate bones. In making this contention, they lay great stress upon the so-called terminal length of the latter, which includes not only the linea terminalis, but also its imaginary continuation, which extends from the ventral margin of the sacro-iliac articulation to the iliac crest just above the superior-posterior spine (Figs. 29, 30). In the normal adult pelvis, the terminal length measures from 19.5 to 21 centimeters, and is divided into three parts—the sacral, iliac, and pubic portions. The first extends from the posterior margin of the iliac crest to the ventral margin of the articular surface, the second from the latter to the line upon the linea terminalis which indicates the union of the iliac and pubic bones, and the third from that point to the anterior end of the pubic bone. These portions measure 6.5 to 7, 6 to 6.5,



FIG. 29.—SHOWING TERMINAL LENGTH AS SEEN FROM ABOVE.  $\times \frac{1}{2}$ .



FIG. 30.—SHOWING TERMINAL LENGTH AS SEEN FROM BELOW.  $\times \frac{1}{2}$ .

and 7 to 7.5 centimeters respectively, and therefore are of practically equal length. During the period of development, the sacral portion grows from the cartilage covering the iliac crest, the iliac portion from the upper limb of the Y-shaped cartilage of the acetabulum, and the pubic portion from the latter as well as from the symphyseal cartilage.

Up to the seventh or eighth year the sacrum increases steadily in width, and then ceases to grow until just before puberty, when it rapidly attains its full development. During the former period the superior strait grows relatively more rapidly in its transverse diameter, and therefore assumes a flattened shape. Normally, the iliac portion of the innominate bone increases steadily in length, until it has attained its full development just before puberty, while the sacral and pubic portions grow much more slowly. Accordingly, as a result of these variations, combined with the arrested growth of the sacrum, the antero-posterior diameter of the superior strait will equal or exceed the transverse diameter in length, so that some time between the eighth and twelfth year the pelvic inlet will become round

or even oval in shape, with its long diameter extending antero-posteriorly. This, however, is only a transient phenomenon, as shortly before puberty the sacrum suddenly begins to increase rapidly in width, and the pubic bones in length, so that the superior strait soon reassumes its typical flattened shape with the long diameter extending transversely.

Breus and Kolisko, therefore, contend that these variations indicate that the changes in shape of the pelvis must be attributed to something more than mere mechanical influences, since the latter come into play in infancy and continue as long as the individual is able to sit up or walk. Were they the only factors concerned, the pelvis would necessarily continue to become more and more flattened, until it had attained its ultimate form, whereas the occurrence of a rounded superior strait between the eighth and twelfth year clearly indicates that some other factor must be concerned. As yet they have advanced no explanation for the variable rate of growth of the sacrum and the component parts of the innominate bone, but they nevertheless hold that its occurrence must preclude the acceptance of the mechanical theory to the exclusion of all others, while at the same time they admit that the latter may also play an important part in the development of the pelvis.

The effect of the mechanical factors is particularly emphasized in certain abnormal types, more especially in the production of certain varieties of contracted pelves, and has been exhaustively studied by Von Meyer and Schroeder. In rare instances, as in a case recorded by Gurlt, none of the mechanical forces came into play, and then one has an opportunity of studying the development of the pelvis in their absence. In Gurlt's case, autopsy upon a thirty-one-year-old hydrocephalic woman, who had been bedridden since infancy and had never sat or walked, showed that the pelvis had retained its foetal characteristics.

The cohesive force exerted at the symphysis pubis cannot act by itself, as it is manifested only when the force exerted by the body weight causes a tendency toward gaping of the pubic bones. Likewise, the effect of the upward and inward force exerted by the femora cannot be observed by itself, as this force comes into play only when it has to react against that resulting from the body weight. Nor has the action of the body weight alone ever been observed, though theoretically it might be noted in an individual presenting a split pelvis (congenital lack of union at the symphysis pubis) who had never walked. Its action, however, has been studied experimentally by Freund, who suspended a cadaver by the iliac crests after cutting through the symphysis, and found that the innominate bones gaped widely.

The effect of the combined action of the body weight and the force exerted by the femora has been studied by Litzmann in cases of congenital absence of the symphysis pubis. In such circumstances there is a marked transverse widening of the posterior portion of the pelvis, while the force exerted by the femora causes the anterior portions of the innominate bones to become almost parallel.

The action of the body weight and the cohesive force exerted at the symphysis, without the upward and inward pressure exerted by the femora,

can be studied in individuals whose lower extremities are absent, and occasionally in cases of congenital dislocation of the hips. Holst has described a case in which the lower extremities were congenitally absent, the pelvis being characterized by a marked increase in width and a marked decrease in its antero-posterior diameter. Owing to the excessive pressure exerted upon the tubera ischii in the absence of the counteracting force exerted by the femora, the innominate bones were rotated in such a manner as to turn their crests inward and the tubera ischii outward, thus producing a marked transverse widening of the inferior strait. More or less similar changes may be observed in the cases of congenital dislocation of the hip in which the patients have never walked.

The effect of the various mechanical influences is particularly emphasized when they are exerted upon pelvises whose bones are softened by disease, as in rhachitis and osteomalacia. But the consideration of the changes so produced will be deferred until the study of the deformed pelvis is taken up.

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## CHAPTER II

### THE FEMALE ORGANS OF GENERATION

For convenience in description and on account of their differences in function, the female organs of generation are divided into two groups—the external and the internal—the vagina being usually classed with the former. The external organs, together with the vagina, serve more especially for copulation, while the internal organs are directly concerned with the development and birth of the fœtus.

### THE EXTERNAL GENERATIVE ORGANS

The term pudendum is occasionally applied to the external organs of generation, although the more common designation is the *vulva*. This includes everything which is visible externally from the lower margin of the pubis to the perineum—namely, the Mons Veneris, the labia majora and minora, the clitoris, vestibule, hymen, urethral opening, and various glandular and vascular structures.

**Mons Veneris.**—The Mons Veneris is the name given to the fatty cushion which rests upon the anterior surface of the symphysis pubis. After puberty the skin over it is covered by a thicker or thinner growth of crinkly hair, which is sometimes described as the “*escutcheon*.” Generally speaking, the distribution of the pubic hairs differs considerably in the two sexes. In the female they occupy a triangular area whose base corresponds to the upper margin of the symphysis, while a few hairs extend down over the outer surface of the labia majora. In the male, on the other hand, the escutcheon is not so circumscribed, as the hairs composing it extend triangularly upward toward the umbilicus and downward over the inner surface of the thighs. These differences were described in detail by Ploss, and at one time it was believed that they might be of value in determining the sex in doubtful cases. But Schultze showed that such variations were not absolutely characteristic, and my own experience has convinced me that the female escutcheon not infrequently approaches the male type.

**Vulva.**—In the restricted sense, the term vulva (from the Latin *valva*, a folding-door), or rima pudendi, is applied only to the structures lying beneath the Mons Veneris. Its position varies according to the inclination of the pelvis, but it usually runs horizontally when the woman is in the erect position. It presents marked individual variations in appearance,



but its most noteworthy differences are dependent upon the age of the person and whether or not she has borne children.

**Labia Majora.**—On either side of the vulva extends a rounded mass of tissue, the labium majus. The labia majora vary markedly in appearance, according to the amount of fat beneath them. They are less prominent after childbearing, and in old age usually assume a shriveled appearance. Ordinarily they measure 7 to 8 centimeters in length, 2 to 3 centimeters in width, and 1 to 1.5 centimeters in thickness. They are somewhat lozenge-shaped, and become narrower at their lower extremities. In children and virginal adults they usually lie in close apposition and com-



FIG. 31.—EXTERNAL GENITALIA OF NULLIPAROUS WOMAN, LABIA IN CONTACT.



FIG. 32.—EXTERNAL GENITALIA OF MULTIPAROUS WOMAN, LABIA SPREAD APART.

pletely conceal the underlying parts, whereas in multiparous women they often gape widely. Until recently it was usually stated that they were connected above and below by the anterior and posterior commissures of the vulva, but Luschka has shown that they are directly continuous with the Mons Veneris above, and fade away into the perineum posteriorly.

Each labium majus presents two surfaces, an outer and an inner. The outer surface corresponds in structure to the adjacent skin, and after the age of puberty is more or less thickly covered with hair. In women who have never borne children the inner surface is moist and resembles a mucous membrane in appearance; whereas in multiparæ it becomes more skin-like, but is not covered with hair. It is richly supplied with sebaceous glands. Beneath the skin there is a layer of dense connective tissue, which is rich in elastic fibers and adipose tissue, but does not contain mus-

cular elements. Beneath this layer, which corresponds to the tunica dartos of the scrotum, is a tolerably dense mass of fat, to which the labium owes the greater part of its size. This fatty tissue is supplied with an abundant plexus of veins, which may rupture as the result of external violence or injury sustained during labor, and give rise to an extravasation of blood or hæmatoma.

The labia majora are analogous to the scrotum in the male, and at their upper ends receive the termination of the round ligaments. Exceptionally one or both of the inguinal canals, which in the female are designated as the canals of Nuck, may remain patent, so that in rare instances there results a hernial sac which usually contains intestine, but occasionally the tube or ovary, and possibly even the uterus.

**Labia Minora.**—On spreading apart the labia majora two triangular structures are seen, which meet together at the uppermost portion of the vulva and more or less resemble a cockscomb in appearance. These are the labia minora or *nymphae*, so called because they were supposed to direct the course of the urine. They vary markedly in size and shape, and in nulliparous women are usually hidden by the labia majora. In multiparæ, on the other hand, they project beyond them.

The labia minora consist of thin folds of tissue, which when protected present a moist, reddish appearance, similar to that of a mucous membrane. They are, however, covered by stratified epithelium, into which project numerous papillæ. They have no hairs upon them, but contain many sebaceous follicles and occasionally a few sweat glands. Their interior portions are made up of connective tissue, in which are many vessels and a few non-striated muscular fibers, so that they are classed among the erectile structures. They are extremely sensitive, and are abundantly supplied with the several varieties of terminal nerve-endings, as has been shown by the work of Krause, Carrard, and Webster.

The labia minora converge anteriorly, each dividing toward its upper extremity into two lamellæ. Of these the two lower fuse together and form the *frenulum clitoridis*, while the upper ones make the *preputium*. Posteriorly they either pass almost imperceptibly into the labia majora or approach the middle line as low ridges, which fuse together and form the *frenulum labiorum* or *fourchette* (Luschka, Cullingworth, and Nagel).

According to Nagel, the labia minora are homologous with the skin upon the under surface of the penis. Not infrequently they become considerably hypertrophied, either from unknown causes or as a result of masturbation. Among the Hottentots they assume immense proportions, and project from the vulva in the form of an apron some centimeters long. Among certain uncivilized races voluminous labia minora are considered to enhance the beauty of their possessors, and artificial means are employed to bring about an increase in their size. According to Ploss, the Nubians and many other races practice *infibulation* as part of their religious ceremonial. In this operation, which is performed just before the age of puberty, the edges of the labia are freshened with a knife, and then sutured together in such a manner as to leave an opening only



large enough to permit the escape of the menstrual flow. In such circumstances a second operation is necessary before marriage can be consummated.

**Clitoris.**—The clitoris is situated at the most anterior portion of the vulva, and projects through the branched extremities of the labia minora, which form its prepuce and frenulum. It is the analogue of the penis in the male, from which it differs in not possessing a corpus spongiosum, and in not being perforated by the urethra. It consists of a glans, a corpus, and two crura. The crura are long, narrow structures which arise from the inferior surface of each ischio-pubic ramus and fuse together in the middle line, just below the pubic arch, to form the body of the clitoris. The clitoris is usually a very rudimentary organ and rarely exceeds 2 centimeters in length, even when in a state of erection. It is sharply bent on itself, owing to traction exerted upon it by the labia minora, whose anterior extremities, as has already been said, furnish the prepuce and frenulum. As a result, its free end looks downward and inward toward the vaginal opening. At the end of the body is the glans, which rarely exceeds a small pea in size. It is covered by squamous epithelium, is richly supplied with nerve-endings, and is extremely sensitive. The entire clitoris is very erectile, and its vessels are connected with the vestibular bulbs by means of the pars intermedia. Fig. 33 gives a good idea of the relations of the clitoris, its crura, and the vestibular bulbs. We are indebted to Kobelt for most of our knowledge concerning this organ, and since the appearance of his monograph, in 1844, the clitoris has been regarded as the chief seat of voluptuous sensation.

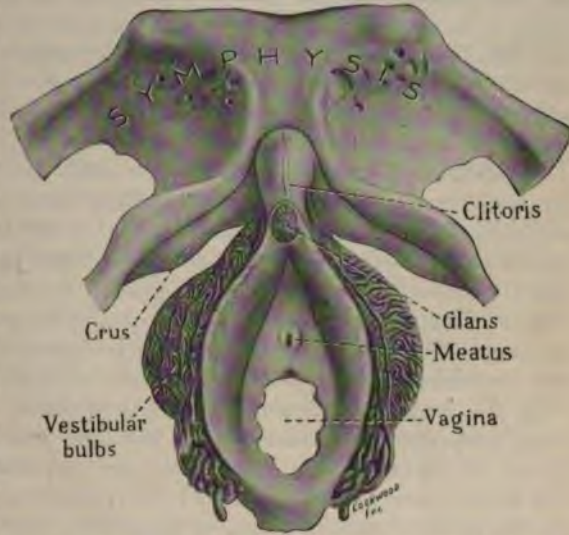


FIG. 33.—PREPARATION SHOWING CLITORIS AND ITS VASCULAR SUPPLY.

(Modified from Chrobak and Rosthorn.)

About the middle of the last century Baker Brown proposed its amputation as a panacea for nearly all the ills to which women are subject, and for a short time the operation of *clitoridectomy* enjoyed a marked vogue, but has since been completely abandoned. Among many of the aboriginal races the same operation had been performed from time immemorial as a religious rite, and was designated as "girl circumcision." Occasionally the clitoris may become considerably hypertrophied, so as to

markedly resemble the penis, and not a few cases of so-called hermaphroditism are to be explained by this condition.

**Vestibule.**—The vestibule is the almond-shaped area which is inclosed between the labia minora and extends from the clitoris to the fourchette. It is the remnant of the urogenital sinus of the embryo, and is perforated by four openings—the urethra, the vaginal opening, and the ducts of Bartholin's glands. Considerable uncertainty exists as to its boundaries, for the reason that the French anatomists usually describe it as a triangular area, bounded above by the labia minora and below by the vaginal opening. The posterior portion of the vestibule, between the fourchette and the vaginal opening, is called the *fossa navicularis*. This is rarely observed except in nulliparous women, as it usually becomes obliterated after childbirth.

**Vestibular Glands.**—In connection with the vestibule, certain glandular structures—the *glandulæ vestibulares majores* and *minores*—are usually described. The former are designated as *Bartholin's glands*, or the glands of Duverney, who first described them in the cow. They are two small structures varying from a pea to a small bean in size, and are situated beneath the vestibule, opposite the lateral margins of the vaginal opening. They lie under the constrictor muscle of the vagina, and in a few instances are found to be partially covered by the vestibular bulbs. They are compound racemose glands; their ducts, from 1.5 to 2 centimeters long, open upon the sides of the vestibule just outside the lateral margin of the vaginal orifice. In caliber they are usually small, and the lumen will admit only a bristle. Under the influence of sexual excitement the glands secrete a small amount of yellowish material. The ducts not infrequently harbor gonococci, which may gain access to the gland and cause it to suppurate, so that the entire labium becomes markedly distended by a collection of pus.

The *glandulæ vestibulares minores* are a number of small mucous glands which open upon the upper portion of the vestibule. Their orifices are occasionally several millimeters in diameter, and in such cases they are designated as *lacunæ*.

**Urethral Opening.**—The mouth of the urethra, or *urinary meatus*, is situated in the middle line of the vestibule, 1 to 1.5 centimeters below the pubic arch and a short distance above the vaginal opening. It usually presents a puckered appearance, and its orifice appears as a vertical slit, which on distention is 4 or 5 millimeters in diameter. The *paraurethral ducts* open upon the vestibule on either side of the urethra, and occasionally upon its posterior wall, just inside its mouth. They are of small caliber,  $\frac{1}{2}$  millimeter in diameter, of varying length, and in this country are generally known as Skene's ducts. They were, however, described by Malpighi in the seventeenth century. Considerable discussion has arisen as to their origin, and certain observers, notably Kocks, believe that they represent the lower extremities of the Wolffian ducts. Most authorities, however, do not share this view, and believe that they are simply exaggerated *lacunæ*.

**Vestibular Bulbs.**—Lying beneath the mucous membrane of the vestibule, on either side, are the vestibular bulbs. These are almond-shaped,

erectile bodies, 3 to 4 centimeters long, 1 to 2 centimeters wide, and 0.5 to 1 centimeter thick. They lie in close apposition to the ischio-pubic rami, and are partially covered by the ischio-cavernosus and constrictor vaginae muscles. Their lower ends usually terminate about the middle of the vaginal opening, while their anterior extremities extend upward toward the clitoris, where they are united by the pars intermedia through which the blood from them reaches that organ. They were first described by Kobelt, and their vascular connections have been exhaustively studied by Gussenbauer.

Embryologically they correspond to the corpus spongiosum of the penis. During parturition they are usually pushed up beneath the pubic arch, but, as their posterior ends partially encircle the vagina, they are liable to be injured to a greater or less extent, and their rupture may give rise to a hæmatoma of the vulva, or to profuse external hæmorrhage if the tissues covering them are torn through.

**Vaginal Opening and Hymen.**—The vaginal opening occupies the lower portion of the vestibule and varies markedly in size and shape in different individuals. In virgins it is entirely hidden from view by the overlapping labia minora, and, when exposed by folding them back, appears almost completely closed by a membranous structure known as the hymen.

The hymen presents marked differences in shape and consistence. In the new-born child it is a redundant structure which projects considerably beyond the surrounding parts, while in adult virgins it is a membrane of varying thickness which closes the vaginal opening more or less completely, and presents an aperture which varies in size from a pin's point to a caliber which will readily admit the tip of one or even two fingers. The hymeneal opening is usually crescentic or circular in shape—*hymen semilunaris* or *annularis*. In rare instances it may assume other forms, which have been studied more particularly by Dohrn and Budin; the most important varieties being the cribriform, septate, and denticulate or fimbriated hymen. In very rare instances the membrane may be imperforate and lead to the retention of the menstrual discharges. Dohrn devoted particular attention to the fimbriated variety, and stated that it might be mistaken by an inexperienced observer for a ruptured hymen, so that this type possesses some little medicolegal interest.

According to the embryological researches of Nagel, which have been confirmed by Gellhorn and Taussig, the hymen represents the lowest portion of the vagina, which in early embryos is composed of a solid mass of epithelial cells. After proliferating rapidly for a time the most centrally situated cells begin to degenerate and a lumen is produced, except at the lower extremity of the mass, where the cells persist and give rise to the hymen. The hymen, therefore, is a fold of tissue presenting a structure similar to that of the vagina—namely, a connective-tissue core with numerous elastic fibers which is covered on either side by a layer of stratified epithelium, in which are numerous papillæ containing vessels and occasionally nerve-endings.

The hymen may vary markedly in consistence in different individuals. According to Dohrn, many types are observed—from a delicate structure



resembling a spider's web to a fleshy, ligamentous, or even cartilaginous membrane, which in rare instances has even been described as "bony."

In the matter of elasticity, again, wide variations are met with, some hymens being so delicate that they rupture upon the slightest touch, while others, though capable of considerable distention, still remain unbroken, and later may even regain their original appearance.

As a general rule the hymen ruptures at the first coitus, tearing at several points, usually in its posterior portion. The edges of the tears soon cicatrize, and the hymen becomes permanently divided into two or three portions, which are separated by narrow slits extending down to its base. (Plate II.) The extent to which rupture occurs varies with the structure of the hymen and the degree to which it is distended, being most marked when it is delicately formed.

Although it is generally believed by the laity that its rupture is associated with hemorrhage, this is by no means always the case, though in rare instances such a profuse loss of blood may occur as to lead to profound anæmia and even death. This idea is proba-



FIG. 34.—LONGITUDINAL SECTION SHOWING TRANSITION FROM THE CYLINDRICAL EPITHELIUM OF THE UTERUS TO THE CUBOIDAL EPITHELIUM OF THE VAGINA.

From a 10-centimeter embryo (Nagel). U., uterus; V., vagina.

bly based upon the biblical statement that loss of virginity is always associated with loss of blood. Nor is it unreasonable to suppose that considerable bleeding usually occurred among the Hebrews of the biblical period, inasmuch as the girls married very young, and not infrequently before the age of puberty, so that marked disproportion must often have existed between the size of the male and female organs. On the other hand, it must be remembered that where Western civilization prevails full sexual development has usually been attained before marriage.

In rare instances the membrane may be very resistant and surgical interference be required before coitus can be accomplished. Obertauffer, in 1802, reported a case in which the hymen was so tough that it creaked under the knife.



FIG. 35.—SAGITTAL SECTION THROUGH THE LOWER PORTION OF THE VAGINA OF A 14-CENTIMETER EMBRYO (Nagel).

U., urethra; H., hymen; Vag., vagina.



PLATE II.



Infantile.



Annular.



Semilunar.



Imperforate.



Cribriform.



Septate.



Vertical.



Normal injury at coitus.



Carunculae myrtiformes.

SHOWING SEVERAL VARIETIES OF HYMEN.



Occasionally, instead of giving way in the middle, it may be torn loose from its base in the attempt at coitus, while in other cases the penis may dilate the urethral canal instead of entering the vagina. Neugebauer has collected an interesting series of injuries occurring during coitus, many of which were due to the presence of a very resistant hymen.

The changes in the hymen following coitus are often of medico-legal interest, as the physician is occasionally called upon to testify as to the virginity of an individual. Unfortunately, however, it is not always possible to arrive at a decisive conclusion as to this point. In occasional instances the hymen may be destroyed in early childhood, either as the result of masturbation or as a consequence of attempting to get rid of seatworms. Among certain Eastern races, again, it is ruptured in early childhood for purposes of cleanliness. On the other hand, the hymen may not be torn, despite repeated coitus; whereas, in other instances, the denticulate or fimbriated type may be mistaken for a hymen which has been ruptured. Habberda, the Professor of Legal Medicine in Vienna, stated that he was able to make a positive diagnosis of loss of virginity in only about 50 per cent. of the medico-legal cases which he had examined in the course of five years. He believes that in many instances it is impossible to determine whether coitus has taken place or not, unless the individual is seen immediately after the attempt, before the torn surfaces have had an opportunity to unite. Achenbach, in 1890, collected 25, and Kanony, some years later, 43 instances of pregnancy occurring in women with unruptured hymens. Some years ago I saw a case in which conception had occurred through a hymen which presented only a pin-point opening, and more recently one in which an elastic hymen had become invaginated sufficiently to admit the penis, but did not rupture until it yielded to the advancing head at labor.

The changes produced by childbirth are much more marked than those following coitus, and, as a rule, are readily recognized. As the result of the distention incident to the birth of the child, the hymen undergoes pressure necrosis in various places, and after the puerperium the remnants are represented by a number of cicatrized nodules of varying size—the *caruncula myrtiliformes* (Plate 11). Their significance was first emphasized by Schroeder. Practically speaking, they are infallible signs



FIG. 36.—ALMOST UNRUPTURED HYMEN AFTER CHILDBIRTH (Budin).



of previous childbearing, though occasionally they may follow the marked distention and long-continued pressure incident to the removal of large tumors through the vagina. In rare instances the injuries resulting from childbirth are extremely slight, and very exceptionally are entirely lacking. Such cases have been reported by Hyerneaux, Tolberg, Hyrtl, and Budin. Fig. 36 shows the external organs of one of Budin's patients who had given birth to a full-term child.

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## THE VAGINA

The vagina is a musculo-membranous tube which extends from the vulva to the uterus, and is interposed between the bladder and the rectum. It serves three important functions; it represents the excretory duct of the uterus, through which its secretion and the menstrual flow escape; it is the female organ of copulation; and, finally, it forms part of the birth canal at labor. Its course runs almost entirely within the pelvic floor, and it is therefore practically outside of the pelvic cavity. The vaginal canal presents a somewhat S-shaped curvature. The common statement that its course corresponds in direction to that of the pelvic axis is incorrect, since its lower third is parallel to the plane of the superior strait, while its upper portion presents a concavity corresponding to the curve of the rectum.

Anteriorly, the vagina is in contact with the bladder and urethra, from which it is separated by the vesico-vaginal septum. Posteriorly, between its lower portion and the rectum, we have the perineum and recto-vaginal septum; in its median portion it lies in close apposition with the rectum, while its upper portion is separated from it by Douglas's *cul-de-sac*. In view of these relations, Schauta, for purposes of description, has divided its anterior wall into two parts—urethral and vesical—and its posterior wall into three—perineal, rectal, and peritoneal respectively. The urethral portion of the vagina is firmly united to the urethra and vesico-vaginal septum, from which it can be separated only with some difficulty; whereas the vesical portion is loosely attached to the bladder and can be readily detached from it.

The anterior and posterior walls of the vagina lie in contact, a slight space intervening between their lateral margins. When not distended, the canal presents an H-shaped appearance on transverse section, as was first pointed out by Henle. The vagina is capable of marked distention, as is manifested at childbirth or when one attempts to pack it with gauze. The vagina and uterus meet at an acute angle, with its opening looking forward. The upper end of the vagina ends as a blind vault into which the lower portion of the cervix uteri projects. The vaginal vault, or, as it is usually designated, the *fornix*, for convenience of description, is subdivided into the anterior, posterior, and two lateral fornices. As the vagina is attached higher up upon the posterior than upon the anterior wall of the cervix, the posterior fornix is considerably deeper than the anterior.

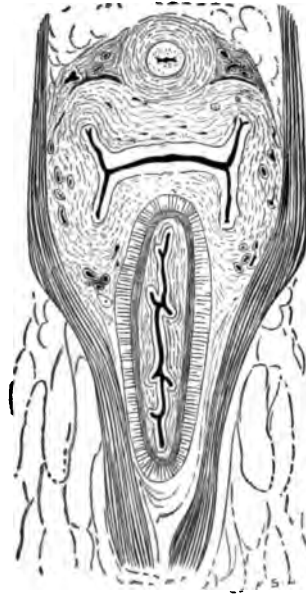


FIG. 37.—H-SHAPED LUMEN OF VAGINA (Henle).

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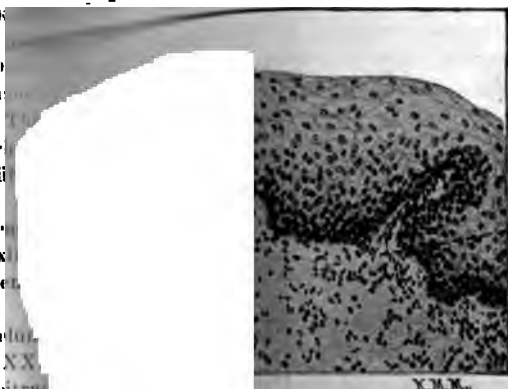


FIG. 20. X 90.

ct., connective tissue.

submucosa, a thin layer of con- blood-vessels. Offshoots from it apillæ, just as in the skin, and cosa are small lymphoid nodules. nderlying connective tissue, as peeled off at operations. l, Pretti, and Waldeyer, the is, nor have I, in any of the encountered them. Hennig,



Preuschen, and Cullen, on the other hand, affirm that they are not infrequently present. It is true that in rare instances Veit and Davidsohn found a few structures which the latter considered represented aberrant cervical glands, but I do not believe that typical glands lined by cuboidal or cylindrical epithelium can be considered as normal constituents of the vagina. In women who have borne children one occasionally finds imbedded in the connective tissue masses of stratified epithelium, which may present a central cavity, and sometimes give rise to cystic formation. These, however, are not glands, as they simply represent tags of mucosa which were buried in the repair of vaginal tears following labor.

The muscular layer is not very sharply marked, and is usually described as being composed of two layers of non-striated muscle—an outer, longitudinal, and an inner, circular, layer. At the lower extremity of the vagina, Luschka described a thin band of voluntary muscle, the constrictor or *sphincter vaginae*. This can always be found in perineal dissections, but for practical purposes the levator ani muscle is the real closer of the vagina.

Outside of the muscular layer is a layer of connective tissue which serves to connect the vagina with the surrounding parts. It is quite rich in elastic fibers, and contains an abundant venous plexus.

In the non-pregnant condition the vagina is kept moist by a small amount of secretion from the uterus; but in pregnancy a well-marked vaginal secretion is present, which, according to Döderlein and most subsequent observers, normally consists of a dry, thick, white, curd-like material composed of cast-off epithelium and many bacteria, and presents a markedly acid reaction. A great deal of work has been done upon the bacterial flora of the vaginal secretion in pregnancy, and all observers agree that bacillary forms predominate, though cocci are not infrequently seen. The consensus of opinion is that the ordinary pyogenic organisms are never present in the vaginal secretion of healthy pregnant women (Krönig and Williams). The subject will be considered in detail in the chapter on Puerperal Infection.

The vagina possesses an abundant vascular supply, its upper third being supplied by the cervicovaginal branches of the uterine arteries, its middle third by the inferior vesical arteries, and its lower third by the median hemorrhoidal and internal pudic arteries. Immediately surrounding the vagina is an abundant venous plexus, the vessels from which follow the course of the arteries and eventually empty into the hypogastric veins.

The distribution of lymphatics has been very accurately studied by Poirier, who found that the lymphatics from the lower third of the vagina empty into the inguinal lymph glands, those from its middle third into the hypogastric, and those from its upper third into the iliac glands.

The vagina is formed by the fusion of the terminal ends of the Müllerian ducts, which, according to Nagel, reach the urogenital sinus in embryos 2.5 to 3 centimeters long. As has already been said, when considering the development of the hymen, the vagina is originally solid, and is made up of a mass of polygonal epithelial cells, its lumen resulting from their degeneration, which commences at about the third month of gestation. (See Fig. 34.)

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## THE UTERUS

The uterus is a muscular structure, partially covered by peritoneum, and presents a cavity lined by mucous membrane. It is the organ of menstruation, and during pregnancy serves for the reception, retention, and nutrition of the ovum, which it expels at the time of labor by its contractions.

The non-pregnant uterus is situated in the pelvic cavity between the bladder and rectum, its inferior extremity projecting into the vagina. Almost its entire posterior wall is covered by peritoneum, the lower portion of which forms the anterior boundary of Douglas's *cul-de-sac*, only the upper portion of the anterior wall is so covered, its lower portion being united to the posterior wall of the bladder by a tolerably thick layer of connective tissue.

Roughly speaking, the uterus resembles a flattened pear in appearance, and consists of two unequal parts: an upper triangular portion—the *corpus*—and a lower, cylindrical, or fusiform portion—the *cervix*. The anterior surface of the corpus is almost flat, while its posterior surface is markedly convex. In view of the fact that the former, which looks downward and forward, rests upon the bladder, while the latter is in contact with the intestines, His has suggested that the surfaces be described as vesical and intestinal, instead of anterior and posterior respectively. The Fallopian tubes come off from the *cornua* of the uterus—i. e., at the junction of the superior and lateral margins on either side—the convex upper margin between their points of insertion being known as the *fundus uteri*. The lateral margins extend from the insertion of the Fallopian tubes on either side to the pelvic

floor. They are not covered by peritoneum, but receive the attachments of the broad ligaments.

The uterus presents marked variations in size and shape, according to



FIG. 39.—ANTERIOR ASPECT OF UTERUS.  
× 1.



FIG. 40.—POSTERIOR ASPECT OF UTERUS.  
× 1.

the age of the individual, and whether or not she has borne children. The infantile organ varies from 2.5 to 3 centimeters in length; that of adult virgins measures from 5.5 to 8, 3.5 to 4, and 2 to 2.5 centimeters in its greatest vertical, transverse, and antero-posterior diameters respectively, as compared with 9 to 9.5, 5.5 to 6, and 3 to 3.5 centimeters in multiparous women. Virginal and parous uteri also differ considerably in weight, the former ranging from 40 to 50, and the latter from 60 to 70 grams. The relation between the length of the corpus and that of the cervix likewise varies widely. In the young child the former is only half as long as the cervix; in young virgins the two are of equal length, or the corpus may be slightly longer. In multiparous women, on the other hand, the relation is reversed, and the cervix represents only a little more than  $\frac{1}{3}$  of the total length of the organ.

On sagittal section it is seen that the great bulk of the uterus is made up of muscular tissue, and that the anterior and posterior walls of its body lie almost in contact, the cavity between them appearing as a mere slit, while that of the cervix is fusiform in shape with a small opening above and below—the internal and the external os. Veit and Aschoff have pointed out that the lowermost portion of the uterine cavity is very con-



FIG. 41.—LATERAL ASPECT OF UTERUS, SHOWING SUPRAVAGINAL AND INFRAVAGINAL PORTIONS OF CERVIX AND ARRANGEMENT OF PERITONEAL COVERING. × 1.



## THE FEMALE ORGANS OF GENERATION

the isthmus uteri—whose upper end is sometimes confused with the internal os.

In frontal section the cavity of the body of the uterus presents a triangular appearance, while that of the cervix retains its fusiform shape.

After child-bearing the triangular appearance becomes less marked, and its margins become concave instead of convex, as in the virginal condition.

**Cervix Uteri.**—The cervix is the portion of the uterus which lies below the internal os. Externally its upper boundary is indicated by the point at which the peritoneum is reflected from the uterus on to the bladder.

It is divided, by the attachment of the vagina, into two parts: the supravaginal and infravaginal portions of the cervix. The former is covered on its posterior surface while its lateral and anterior surfaces are in contact with the lesser folds of the broad ligaments and bladder.

The infravaginal portion of the cervix, which is usually designated as



FIG. 43.—CERVIX UTERI.



FIG. 44.—UTERUS AND APPENDAGES OF FOURTEEN-YEAR-OLD GIRL.  $\times \frac{1}{2}$ .



FIG. 44.—UTERUS AND APPENDAGES OF FOURTEEN-YEAR-OLD GIRL.  $\times \frac{1}{2}$ .



FIG. 45.—UTERUS AND APPENDAGES OF TWENTY-YEAR-OLD MULTIPARA.  $\times \frac{1}{2}$ .

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small, oval opening resembling a tench's mouth, whence  
on vaginal examination it gives a sensation similar

to that obtained on feeling the cartilage at the end of one's nose. After childbirth the orifice becomes converted into a transverse slit, and when the cervix has been markedly torn during labor it may present an irregular nodular or stellate appearance. These changes are very characteristic, and enable one to assert with tolerable accuracy whether a woman has borne children or not (Figs. 46 and 47).



FIG. 46.—VIRGINAL EXTERNAL OS.

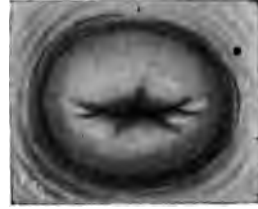


FIG. 47.—PAROUS EXTERNAL OS.

The cervix is composed of connective tissue in which are many nonstriated muscle fibers and a certain amount of elastic tissue, a large part of its distensibility being due to the presence of the latter. The cervical canal, as has already been said, is fusiform in shape, and presents a longitudinal ridge upon its anterior and posterior surfaces, from which numerous others run off transversely, giving the membrane a corrugated appearance—the *arbor vitæ uterina* or *plicæ palmatæ*.

In the adult the *arbor vitæ* is limited to the cervical canal; but in childhood it extends throughout the entire cavity of the uterus, from which it begins to disappear as puberty is approached. In time, after repeated childbirth, it gradually becomes obliterated even in the cervical canal, whose walls become almost smooth (see Figs. 43 to 45).

The mucosa of the cervical canal, embryologically speaking, is a direct continuation of the lining of the uterine cavity, but has become differentiated from it and

possesses a characteristic appearance, so that sections through the canal present a honeycomb-like structure (Fig. 48). The mucosa is composed of a single layer of very high and narrow columnar epithelium, which rests upon a thin basement membrane. The oval

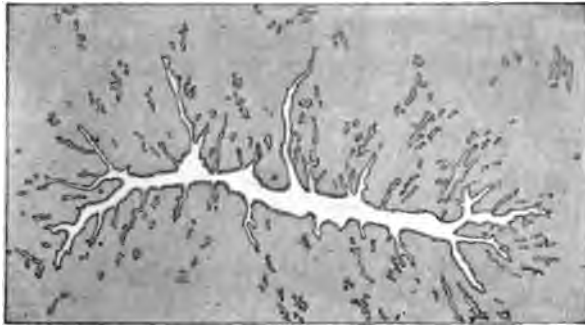


FIG. 48.—CROSS-SECTION THROUGH CERVICAL CANAL.  $\times 6$ .

nuclei are situated near the base of the columnar cells, the upper portions of which present a clear, more or less transparent appearance due to the presence of mucus. It is usually stated that these cells are abundantly supplied with cilia.

The cervical glands extend down from the surface of the mucosa into the stroma. They are of the branching, racemose variety, and are merely reduplications of the surface epithelium, being lined by epithelium of the



same character. Friedländer was the first to demonstrate that it was made up of true "beaker" or mucous cells, which furnish the thick, tenacious secretion of the cervical canal. There is no submucosa in the cervix, the mucosa resting directly upon the underlying tissue.

The mucosa of the vaginal portion of the cervix is directly continuous with that of the vagina, and, like it, consists of many layers of stratified

epithelium. Normally, there are no glands beneath it, but occasionally those from the cervical canal may extend down almost to its surface, and, if their ducts are occluded, may become converted into retention cysts, which shimmer through it and appear as rounded protuberances the size of small peas. These are the so-called Nabothian follicles or *ovula Nabothi*.

Normally, the stratified epithelium of the vaginal portion and the cylindrical epithelium of the cervical canal meet at the external os. This, however, is the case only in early life, as in older persons the stratified epithelium gradually extends up the cervical canal until its lower third, and occasionally its lower half, is covered by it (Friedländer). This change is more especially marked in multiparous women, in whom the lips of the cervix are not infrequently markedly everted; and occasionally, in cases of this character, almost the entire cervical canal may be lined by stratified epithelium.

In rare instances the junction of the two varieties of epithelium may be upon the vaginal portion, outside the external os. This condition was first described by Fischel, who designated it as *congenital ectropion*, and



FIG. 49.—CERVICAL GLAND.  $\times 90$ .

stated that he had observed it in 10 out of 28 uteri of young persons which he had examined. Still more rarely, the entire vaginal portion may be covered by cylindrical epithelium, which may extend down over the vaginal walls. This anomaly was first described by Ruge in a case of imperforate hymen, associated with *hamatokolpos*, in which the entire vagina and the inner surface of the hymen were covered by a single layer of columnar, ciliated epithelium.

**Corpus Uteri.**—The wall of the uterine body is made up of three layers: serous, muscular, and mucous. The serous layer is formed by the peri-

toneum covering the uterus, to which it is firmly adherent except at the margins, where it is deflected to the broad ligaments.

**Endometrium.**—The innermost or mucous layer, which serves as a lining for the uterine cavity, is commonly known as the endometrium. It is a thin, pinkish, velvety membrane, which on close examination is seen to be perforated by large numbers of minute openings—the mouths of the uterine glands. On account of the constant changes to which it is subject during the sexual life of woman, the endometrium varies markedly in thickness, and may measure anywhere from 0.5 to 2 or 3 millimeters without being necessarily abnormal. It consists of a surface epithelium, glands, and interglandular tissue, in which are found numerous blood-vessels and lymphatic spaces.

As the endometrium does not possess a submucosa, it is attached directly to the underlying muscular layer in such a manner that its outer boundary presents irregularities in outline corresponding with the interstices between the muscle bundles. This arrangement is



FIG. 50.—RECONSTRUCTION OF UTERUS, SHOWING SHAPE OF ITS CAVITY AND CERVICAL CANAL.  $\times 1$ .



FIG. 51.—NORMAL ENDOMETRIUM.  $\times 16$ .  
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of considerable importance in connection with the operation of curettage; for, as Düvelius and Werth first showed, it is from the portions included



between the muscle bundles that the endometrium is regenerated after the procedure.

The surface epithelium of the uterine mucosa is composed of a single layer of high columnar ciliated cells, which are closely packed together.



FIG. 52.—ENDOMETRIUM OF NEWLY BORN CHILD.  $\times 150$ .

The oval nuclei are situated in the lower portions of the cells, but not so near their bases as in the cervix. Beneath the epithelium is a thin basement membrane with narrow, spindle-shaped nuclei.

The existence of *cilia* was first demonstrated by Nylander in the sow, but they have since been found in nearly all animals. The researches of Meyer show that the time of their first appearance is variable, as they



FIG. 53.—SENILE ENDOMETRIUM.  $\times 16$ .

may be present at birth, but sometimes do not appear until much later. Hoehne and Mandl state that they are not present upon all cells, but that those provided with cilia occur in discrete patches, while the secretory activity appears to be limited to the non-ciliated cells. The cilia persist

throughout the entire period of sexual activity, and, according to Parviainen, disappear eight or ten years after the menopause.

Up to 1893 it was generally taught that the current produced by them was directed from below upward—namely, from the cervix toward the fundus; but Hofmeier conclusively demonstrated that it is in the opposite direction, and his researches have since been confirmed by Mandl. It may therefore be considered as a definitely established fact that the ciliary current in both the tubes and the uterus is in the same direction, and extends downward from the fimbriated end of the tubes to the external os.

In very exceptional instances the uterine cavity may be lined by stratified epithelium, as in the cases reported by Zeller and F. Friedländer. Such a condition readily explains the possible occurrence of flat-celled carcinoma of the body of the uterus.

Projecting down from the surface of the endometrium are large numbers of small tubular glands—the *uterine glands*. These must be regarded as mere invaginations of the surface epithelium and, in the resting state, resemble the fingers of a glove, though occasionally they branch slightly at their deeper extremities. They extend through the entire thickness of the endometrium to the muscular layer, which they occasionally penetrate for a short distance. They present the same histological structure as the surface epithelium, and are lined by a single layer of high, columnar, ciliated epithelium, which rests upon a thin basement membrane. They secrete small quantities of a thin, alkaline secretion, which serves to keep the uterine cavity moist.

Following the appearance in 1908 of the monograph of Hitschmann and Adler, many investigators have written upon the anatomy of the endometrium. The consensus of opinion now is that it is undergoing constant changes, and consequently will vary greatly in appearance, according as the specimen is obtained before, during or after the menstrual flow. In the former case the endometrium is comparatively thick and contains abundant convoluted or cork-screw-like glands; while in the latter case, it is much thinner and contains only a few tubular glands.

In the child the uterine glands are mere shallow depressions, which, according to Kundrat and Engelman, do not appear until the third year; but the researches of Meyer, which are confirmed by my own studies, show that they are not infrequently present at birth. At the menopause the entire endometrium undergoes atrophic changes; its epithelium becomes flatter, its glands gradually disappear, and its interglandular tissue takes on a more fibrous appearance (see Fig. 53).

The portion of the endometrium lying between the surface epithelium and the underlying muscle, which is not occupied by glands, is filled by an *interglandular* tissue or stroma of an embryonic type. In the resting stage, under the microscope (Figs. 51 and 54), it is seen to be made up of closely packed oval and spindle-shaped nuclei, around which there is very little protoplasm. When the tissues are spread apart by cedema it is readily seen that the cells present a stellate appearance, with branching protoplasmic processes which anastomose one with another. The cells are more closely packed around the glands and blood-vessels than elsewhere. On the other

hand, during the premenstrual stage they become larger and more vesicular in character, and closely resemble decidual cells. Occasionally larger or smaller collections of round cells may be seen between them, though it is uncertain whether or not these are to be regarded as *lymphoid nodules*.

The exact nature of the interglandular tissue has given rise to a great deal of discussion, concerning which the authorities are not yet fully agreed. Minot looks upon it as nothing but embryonic tissue, while Nagel sees it in a resemblance to lymphoid tissue, and Arthur W. Johnstone holds that it is of an adenoid type. On the other hand, Leopold, Championnière, Poirier, and others consider that it represents a lymphatic surface. According to Leopold, the "uterine mucosa should be considered as a

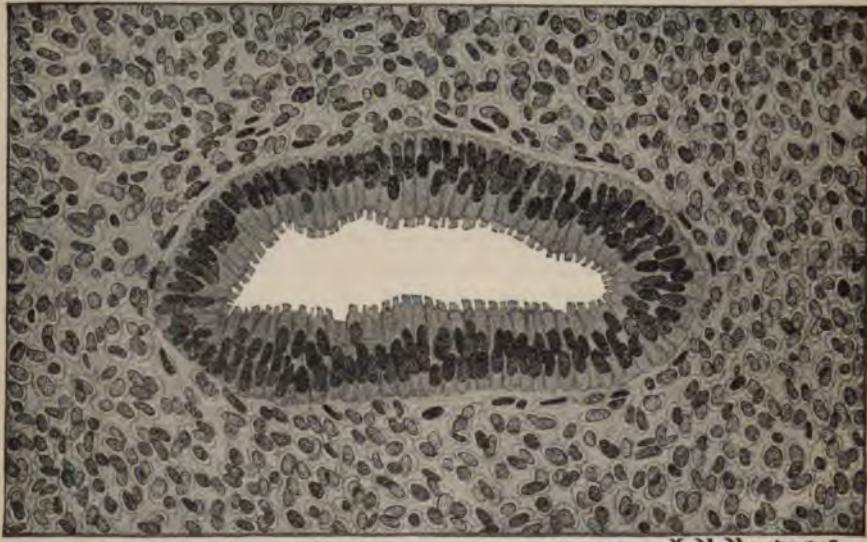


FIG. 54.—UTERINE GLAND AND STROMA.  $\times 420$ .

spread-out lymph-gland (*Lymphdrüsenfläche*), which does not contain true lymph-vessels, but consists of spaces lined by endothelium." There is a certain amount of evidence in support of all of these views, but I am inclined to agree with Minot in considering it as merely an embryonic type of connective tissue.

When preparations from the endometrium are treated by appropriate methods, an abundant reticulum can be demonstrated throughout its entire extent, which forms the scaffolding upon which it is constructed.

The endometrium contains many blood-vessels. The arteries pursue a spiral course and break up into a capillary network just beneath the surface epithelium, from which the blood is returned by a few comparatively large vessels.

**Musculature of the Uterus.**—The major part of the uterus is made up of bundles of non-striated muscle, which are united by a greater or lesser amount of connective tissue, in which are found many elastic fibers (Pick



and Anspach). On section the uterine wall presents a thick, felt-like structure, in which definite layers cannot be distinguished.

A great deal of work has been done upon the arrangement of the musculature both of the pregnant and non-pregnant uterus. Tarnier and Ribemont-Dessaignes were unable to make out definite layers of muscle bundles in the non-pregnant organ, while Bayer, Kreitzer, Veit, and others distinguished several, but did not agree as to their arrangement. All admit, however, that the greater part of the uterine wall is made up of a mass of muscle which is perforated in all directions by blood-vessels, and in which it is impossible to make out any definite arrangement of the bundles—*stratum vasculare*.

Roesger studied the question from a developmental point of view, and demonstrated that the muscle fibers are developed along the course of the blood-vessels, but failed to distinguish any definite arrangement. Similar studies by Werth and Grusdew show that the musculature of the foetal and infantile uterus presents a very simple arrangement, which becomes much more complicated as puberty is approached. During gestation, on the other hand, the uterus undergoes marked hypertrophy, when it becomes possible to distinguish certain distinct layers which will be considered in the chapter on the changes incident to pregnancy.

**Ligaments of the Uterus.**—Extending from either half of the uterus are three ligamentous structures—the broad, round, and utero-sacral ligaments (*ligamenta lata*, *teretia*, and *utero-sacralia*).

The broad ligaments, or *ligamenta lata*, are two wing-like structures which extend from the lateral margins of the uterus to the pelvic walls, and serve to divide the pelvic cavity into an anterior and a posterior compartment. Each broad ligament consists of a fold of peritoneum inclosing various structures within it, and presents four margins for examination—a superior, lateral, inferior, and median. The superior margin, for its inner two thirds, is occupied by the Fallopian tube, while its outer third, extending from the fimbriated end of the tube to the pelvic wall, is known as the *infundibulo-pelvic ligament*—the suspensory ligament of the ovary (Henle)—and serves to transmit the ovarian vessels. The portion of the broad ligament beneath the Fallopian tube is called the *mesosalpinx*, and consists of two layers of peritoneum which are united by a small amount of loose connective tissue, in which is embedded the *parovarium* or organ of Rosenmüller (see Fig. 45).

The parovarium consists of a number of narrow vertical tubules, lined with ciliated epithelium, which connect by their upper ends with a longitudinal duct, which extends just below the tube to the lateral margin of the uterus, in whose muscular wall it ends blindly about the region of the internal os. This canal is the remnant of the Wolffian duct, and in the female is designated as Gartner's duct. The parovarium corresponds to the epididymis and is usually considered as the remains of the Wolffian body. Waldeyer in 1870, however, showed that it represents only the cranial portion of the latter, and designated it as the *epoophoron*, and suggested the term *paroophoron* for its caudal portion.

The latter is the analogue of the organ of Girdaldès, and according to the

exhaustive work of Rieländer is situated near the free end of the broad ligament between the terminal branches of the ovarian artery just before they enter the ovary. The paroophoron consists of a small number of slightly convoluted tubules, lined by non-ciliated epithelium. The organ tends to disappear with advancing years; and is of interest only from the fact that it occasionally gives rise to tumor formations.



FIG. 55.—SECTION THROUGH UTERINE END OF BROAD LIGAMENT.  $\times 3$ .

At its lateral margin, the peritoneal covering of the broad ligament is reflected upon the side of the pelvis. The inferior margin, which is quite thick, is continuous with the connective tissue of the pelvic floor. Through it pass the uterine vessels. Its lower portion—the cardinal ligament of Kocks, the *ligamentum transversale colli* of Mackenrodt, or the *retinaculum uteri* of Martin—is composed of dense connective tissue which is firmly united to the supravaginal portion of the cervix. The median margin is connected with the

lateral margin of the uterus, and incloses the uterine vessels; through it certain muscular and connective-tissue bands extend from the uterus into the broad ligament.

A vertical section through the uterine end of the broad ligament is triangular in shape, with the apex directed upward, while its base is broad and contains the uterine vessels; it is widely connected with the connective tissue covering the pelvic floor and lying behind the bladder, which is designated as the *parametrium*. A vertical section through the middle portion of the broad ligament shows that its upper part is made up mainly of three branches in which the tube, ovary, and round ligament are situated, while its lower portion is not so thick as in the previous section. For further particulars concerning the pelvic connective tissue the student is referred to the careful studies of Jung and Martin.

The *round ligaments*, or *ligamenta teretia*, extend on either side from the anterior and lateral portions of the uterus, just below the insertion of the tubes. Each lies in a fold of the broad ligament and runs in an upward and outward direction to the inguinal canal, through which it passes, to terminate finally in the upper portion of the labium majus. The round ligament varies from 3 to 5 millimeters in diameter; it is composed of non-striated muscle, which is directly continuous with that of the uterine wall, and a certain amount of connective tissue. In the non-pregnant condition it appears as a lax cord, but in pregnancy it undergoes considerable hypertrophy and seems to act as a stay for the uterus. It can be palpated during pregnancy, and by its varying position aids one in diagnosing the location of the placenta.

The *utero-sacral ligaments*—*retractores uteri*<sub>1</sub> (Luschka)—are two



structures which extend from the posterior and upper portion of the cervix, encircle the rectum, and are inserted into the fascia covering the second and third sacral vertebræ. They are likewise composed of connective tissue and muscle, and are covered by peritoneum. They form the lateral boundaries of Douglas's *cul-de-sac*, and are believed to play a part in retaining the uterus in its normal position by exerting traction upon the cervix. ✓

**Position of the Uterus.**—After many years of discussion, anatomists and gynecologists have agreed that the normal position of the uterus, whether pregnant or not, is one of slight ante flexion. With the woman standing upright, the uterus occupies an almost horizontal position and is somewhat bent upon its vesical surface, the fundus resting upon the posterior surface of the bladder, while the cervix is directed backward toward the tip of the sacrum (see Fig. 26). The position of the organ varies markedly according to the degree of distention of the bladder and rectum, but when these are empty the uterus always tends to resume its normal position.

The causes which bring about its ante flexed position have not as yet been definitely determined. Normally, as long as it is *in situ*, the organ is ante flexed, but when removed from the body it immediately straightens out. Schauta would attribute the ante flexion to the action exerted by the vessels when filled with blood, but his explanation does not appear altogether satisfactory. According to Nagel and most embryologists, the ante flexion exists from the earliest stages of development, and is to be accounted for by the fact that the entire body is developed along a curved line. The pressure of the intestines upon the uterus is also believed to play a part, as the light corpus is readily movable, while the comparatively large cervix is held in a fixed position by the small pelvis.

The uterine ligaments were formerly supposed to play an important part in maintaining the uterus in its characteristic position. We have already indicated the functions of the round and utero-sacral ligaments. The upper portion of the broad ligament appears to have no influence upon the position of the uterus, since Mackenrodt has demonstrated that it can be cut through without causing any change in position, which only occurs when its deeper portion—the ligamentum transversale colli—is divided.

**Blood-vessels of the Uterus.**—The vascular supply of the uterus is derived from two sources: principally from the uterine, and to a lesser extent from the ovarian, arteries. The uterine artery is the main branch of the hypogastric, which, after descending for a short distance, enters the base of the broad ligament, crosses the ureter, and makes its way to the side of the uterus. Just before reaching the supravaginal portion of the cervix, it divides into a larger and a smaller branch, the latter—the cervico-vaginal artery—supplying the lower portion of the cervix and the upper portion of the vagina. The main branch turns abruptly upward and extends as a very convoluted vessel along the margin of the uterus, giving off a branch of considerable size to the upper portion of the cervix, and numerous smaller ones, which penetrate the body of the uterus. Just before reaching the tube it divides into three terminal branches—the fundal, tubal, and ovarian—the last of which anastomoses with the terminal branch of the ovarian artery;

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the second, making its way through the mesosalpinx, supplies the tube, and the fundal branch is distributed to the upper portion of the uterus.



FIG. 56.—BLOOD SUPPLY OF UTERUS (Kelly).

The ovarian or internal spermatic artery is a branch of the aorta and enters the broad ligament through the infundibulo-pelvic ligament. On reaching the hilum of the ovary it breaks up into a number of small



branches which enter the organ, while its main stem traverses the entire length of the broad ligament and makes its way to the upper portion of the margin of the uterus, where it anastomoses with the ovarian branch of the uterine artery. For further particulars concerning the vascular supply the student is referred to the comprehensive monographs of Freund, Farabonf, and Kownatski. X

It is generally stated that there is very little communication between the vessels on the two sides of the uterus, but the experiments of Clark have positively demonstrated that such is not the case. This observer found that when the uterine artery on one side was injected the fluid

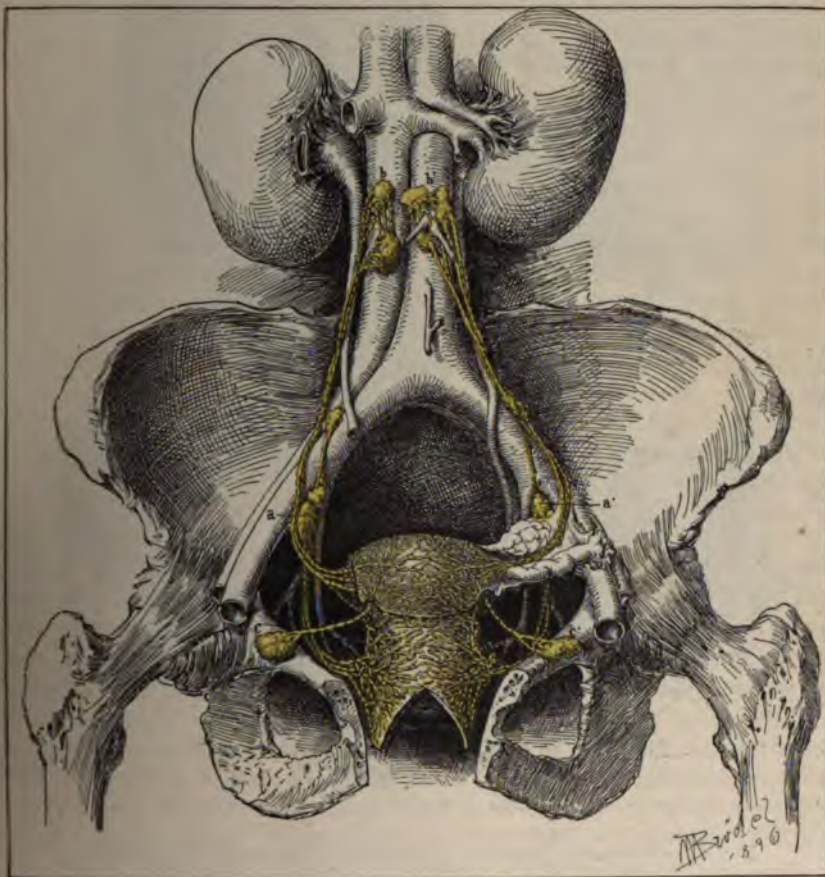


FIG. 57.—LYMPHATICS OF UTERUS (Kelly).

escaped from the opposite uterine artery before it began to flow from the veins, thus indicating the presence of numerous arterial anastomoses in the substance of the uterus.

The veins from the uterus form an abundant plexus around each uterine artery, and unite to form the uterine vein on either side, which then



empties into the hypogastric vein, which makes its way into the internal iliac. The blood from the ovary and upper part of the broad ligament is collected by a number of veins, which form a large plexus within the broad ligament—the *pampiniform plexus*—the vessels from which terminate in the ovarian vein. The right ovarian vein empties into the vena cava, while the left empties into the renal vein.

**Lymphatics.**—The careful work of Leopold, Poirier, Bruhns, and others

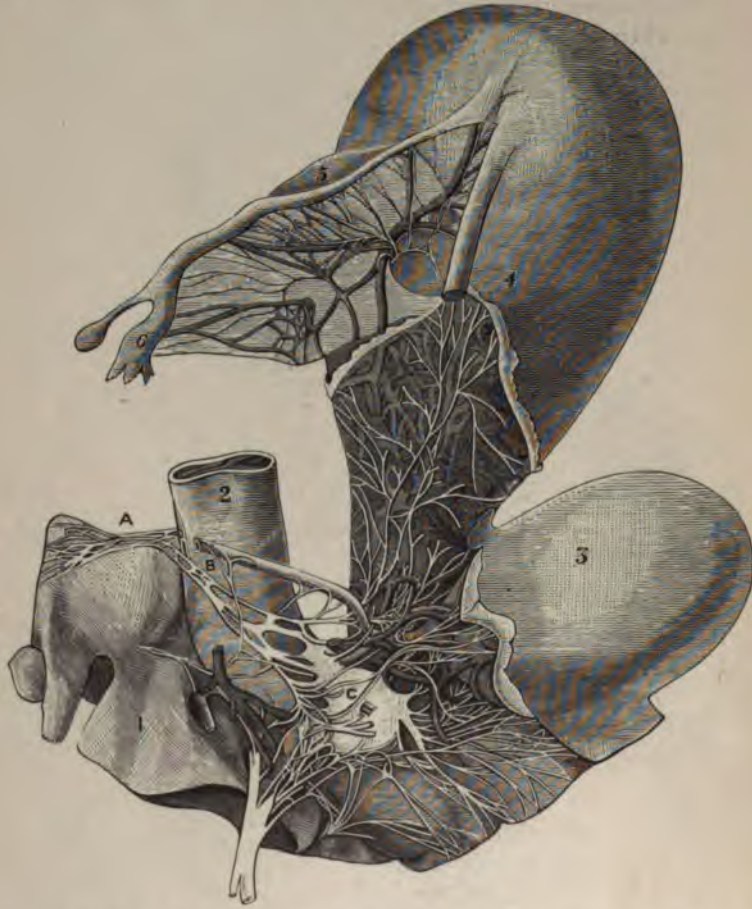


FIG. 58.—NERVOUS GANGLIA OF PREGNANT UTERUS (Frankenhäuser).

A, plexus uterinus magnus; B, plexus hypogastricus; C, cervical ganglion.

has given us a fairly definite idea of the lymphatic system of the uterus. The endometrium is abundantly supplied with lymph spaces, but possesses no true lymphatic vessels. Immediately beneath it in the muscularis a few lymphatics may be found, which become better defined as the peritoneum is approached, and form an abundant lymphatic plexus just beneath it, which is especially marked on the posterior or intestinal wall of the uterus.

The lymphatics from the various portions of the uterus are connected with several sets of glands—those of the cervix terminating in the hypogastric glands, which are situated in the spaces between the external iliac and hypogastric arteries. The lymphatics from the body of the uterus are distributed to two groups of glands, one set of vessels making their way to the hypogastric glands, while another set, after joining certain lymphatics from the ovarian region, terminate in the lumbar glands, which are situated in front of the aorta at about the level of the lower portion of the kidneys (see Fig. 57).

**Innervation.**—The nerve supply of the uterus is derived partly from the cerebro-spinal, but principally from the sympathetic nervous system. The cerebro-spinal system is represented by a few fibers from the third and fourth sacral nerves, and Herlizka has demonstrated the presence of medullated nerve-fibers in the uterine wall, which showed free endings between the muscle bundles. Herff and Gawronsky have described ganglionic cells in the muscularis, and the latter has been able to follow isolated nerve-fibers into the epithelial cells of the endometrium.

The greater portion of the nerve supply, however, is derived from the sympathetic system, and has been studied particularly by Lee, Frankenhäuser, Rein, and Pissemiski. According to the authors first mentioned, large nerve-trunks from the inter-iliac plexus pass down on either side of the rectum, and, following the course of the utero-sacral ligaments, terminate in the large *cervical ganglion*. This structure was first discovered by Lee; it lies to the side of and behind the cervix, and from it numerous fibers make their way to the uterus, as is readily seen in Fig. 58. Pissemiski in 1903 made extensive investigations upon the subject based upon the careful study of 50 specimens. He concluded that the cervical ganglion of Lee and Frankenhäuser does not exist as such, but that a large plexus can be found on either side of the cervix which he designated as the *fundamental plexus of the uterus*. This is composed of branches from the second, third, and fourth sacral nerves, as well as others from the hypogastric plexus and the sympathetic. Keiffer has shown that small but definite ganglia are present in the course of the nerves, especially where the various branches cross one another.

**Development of the Uterus.**—It is universally admitted by embryologists that both the tubes and the uterus are derived from the Müllerian ducts. According to His, the first signs of their development can be noted in embryos having a body length of from 7 to 7.5 millimeters, when a thickening may be noticed in the coelomic epithelium on the outer margin of each Wolffian body. These gradually become converted into two epithelial ducts, which converge and eventually meet together in the middle line, terminating in the urogenital sinus.

The Müllerian ducts reach the urogenital sinus in embryos having a body length of 2.5 to 3.5 centimeters. Their upper ends form the Fallopian tubes, while their lower portions fuse together to form the uterus and vagina. The fusion of the Müllerian ducts is usually completed at about the third month, though the point at which the process is to occur is indicated at a much earlier period by the position of the round ligaments.



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## THE FALLOPIAN TUBES

The Fallopian or uterine tubes are more or less convoluted muscular canals which extend from the uterine cornua to the ovaries. They are covered by peritoneum and possess a lumen lined by mucous membrane. They represent the excretory ducts of the ovaries, as it is through them that the ova gain access to the uterine cavity. They are more or less cylindrical in shape, and vary from 8 to 14 centimeters in length.

For convenience in description, each tube may be divided into several parts—the uterine portion, isthmus, ampulla, and infundibulum. The uterine portion is included within the muscular wall of the uterus, and extends from the cornu to the upper angle of the uterine cavity. Its lumen is so small that it will admit only the finest probe. The *isthmus* is the narrow portion of the tube immediately adjoining the uterus, and gradually passes into the wider lateral portion or *ampulla*. The *infundibulum*, or



fimbriated extremity, is the funnel-shaped opening of the lateral end of the tube, the margins of which present a dentate appearance (see Figs. 43 to 45, and Fig. 63).

The tube varies considerably in thickness, the narrowest portion of the isthmus measuring from 2 to 3 millimeters, and the widest portion of the ampulla from 5 to 8 millimeters in diameter.

With the exception of its uterine portion, the tube, throughout its entire length, is included within the upper margin of the broad ligament; it is completely surrounded by peritoneum except at its lower portion, corresponding to the mesosalpinx. The fimbriated extremity opens freely into the abdominal cavity, and one of its fimbriae—the *fimbria ovarica*—

which is considerably longer than the others, forms a shallow gutter which extends almost or quite to the ovary.

Generally speaking, the musculature of the tube is arranged in two layers—an inner, circular, and an outer, longitudinal layer. In its uterine portion a third layer, lying between the circular layer and the mucosa, and composed of longitudinal fibers, may be distinguished. In the lateral portion of the tube the two primary layers become less marked, and in the neighborhood of the



FIG. 59.—TUBAL MUCOSA.  $\times 280$ .

fimbriated extremity are replaced by an interlacing network of muscle fibers. The writer was the first to call attention to the presence of the inner longitudinal layer in the uterine portion of the tube, and his observations have been confirmed by Ballantyne, Mandl, Grusdew, Recklinghausen, and Pick.

The lumen of the tube is lined with a mucous membrane whose epithelium is composed of a single layer of high, columnar cells, which rest upon a thin basement membrane (Fig. 59). According to Schaffer, only a portion of the cells are ciliated. These are arranged in discrete patches, while the non-ciliated cells are supposed to be secretory. There is no submucosa, the epithelium being separated from the underlying muscle by a layer of connective tissue of varying thickness.

The mucosa is arranged in folds which become more complicated as the fimbriated end is approached. The appearance of the lumen varies according to the portion of the tube examined. In the uterine portion four ele-



variations are seen, which together make a figure resembling a Maltese cross. In the isthmic portion of the tube a more complicated appearance can be noted; while in the ampulla the lumen is almost completely occupied by



Fig. 60.



Fig. 61.



Fig. 62.

FIGS. 60-62.—SECTIONS THROUGH UTERINE, ISTHMIC, AND AMPULLAR PORTIONS OF TUBE.  
X 15.

the arborescent mucosa, which upon careful examination is seen to be made up of four very complicated tree-like folds. (Fig. 63.)

The statements of Hennig and Bland-Sutton that the tube possesses glands have since been found to be erroneous, inasmuch as the structures, which they considered as such, are merely depressions between folds of the mucosa. Their absence was conclusively demonstrated by Frommel, who showed that the glandular appearance disappeared upon markedly distending the tube, when the greater part of its lumen became perfectly

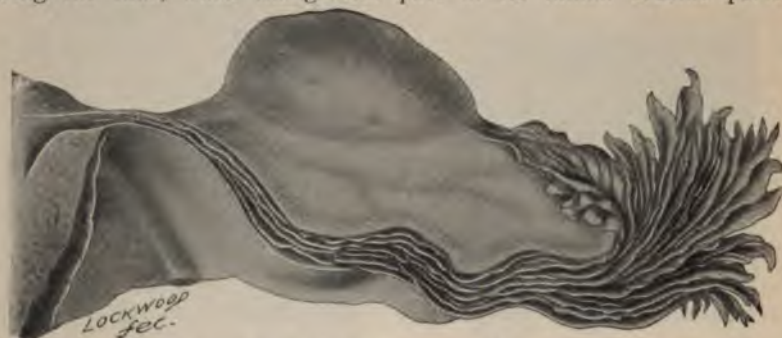


FIG. 63.—LONGITUDINAL FOLDS OF TUBAL MUCOSA (after Sappey).

smooth, with four arborescent folds of mucosa arising from its sides. It is interesting to note that Nature not infrequently performs a similar experiment in cases of hydrosalpinx.

The current produced by the cilia of the tube is directed toward the uterus, as was conclusively demonstrated by the experiments of Pinner, Jani, and Lode, who showed that foreign bodies injected into the abdominal cavity of animals made their way into the tubes and were gradually carried down into the uterus and thence into the vagina.



FIG. 64.—TUBE WITH ACCESSORY OSTIUM.

The tubes are richly supplied with blood-vessels and lymphatics, and the latter sometimes become so dilated as to fill up almost entirely certain sides of the mucosa.

Occasionally, as Richard first pointed out, the tube may possess a second tubulated extremity, which is known as an accessory ostium (Fig. 64). Again, not infrequently small tube-like structures, with miniature tubulated extremities, are found projecting from the exterior of the tube.



As a rule, these are mere *culs-de-sac*, but occasionally one is met with possessing a lumen which communicates with that of the main tube. Several cases of extrauterine pregnancy have been reported in which the fertilized ovum had been arrested in such a structure.

Similar formations are frequently observed upon the anterior surface of the mesosalpinx, but have no connection with the tube. They have been studied more particularly by Kossmann, who designated them as *accessory tubes*. They are probably derived from aberrant portions of the coelomic epithelium.

In very exceptional instances there may be two tubes on one side, Bab having reported two cases of his own, together with five others collected from the literature.

*Diverticula* may occasionally extend from the lumen of the tube for a variable distance into its muscular wall, and reach almost to its peritoneal covering. Such structures were first described by Landau and Rheinsteins and myself. The suggestion that they might play a part in the production of tubal pregnancy would seem plausible, inasmuch as a fertilized ovum, which might chance to make its way into such a diverticulum, would be arrested at its tip and there develop, if suitable conditions existed. Similar structures have also been described by Henrotin and Goebel.

In rare instances the main canal of the tube may branch, and two or even three lumina may be seen in sections. After extending for a certain distance, more or less parallel to the main lumen, they usually rejoin it. It should always be borne in mind that such appearances are usually due to the fact that two or more twists or bends of the tube have been included in one section; although in several instances, by the use of the serial method, I have been able to demonstrate that more than one lumen really existed.

In the new-born child the tubes are markedly convoluted, and present a corkscrew-like appearance, as shown in Fig. 42. This gradually disappears with age, but occasionally the foetal condition persists and may play a not unimportant part in the production of sterility and tubal disease, as was first pointed out by Freund and Schober.

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## THE OVARIES

**General Anatomy.**—The ovaries are two flattened, more or less almond-shaped organs, whose chief function is the development and extrusion of ova. They vary considerably in size, and during the childbearing period measure from 2.5 to 5 centimeters in length, 1.5 to 3 centimeters in breadth, and 0.6 to 1.5 centimeters in thickness (see Fig. 45). After the menopause they diminish markedly in size, and in old women are often scarcely larger than peas.

Normally, the ovaries are situated in the upper part of the pelvic cavity, one surface of each ovary resting in a slight depression in the upper portion of the inner surface of the obturator muscle—the *fossa ovarica* of Waldeyer. With the woman standing, the long axes of the ovaries occupy an almost vertical position, which becomes horizontal when she is on her back. Their situation, however, is subject to marked variations, and it is rare to find both ovaries at exactly the same level.

Each ovary presents for examination two surfaces, two margins, and two poles. The surface which is in contact with the ovarian fossa is called the lateral, and the one directed toward the uterus is known as the median surface. The margin which is attached to the mesovarium is more or less straight, and is designated as the *hilum*, while the free margin is markedly convex and is directed backward and inward toward the rectum. The extremities of the ovary are termed the upper and lower, or tubal and uterine poles respectively.

The ovary is attached to the broad ligament by the *mesovarium*, which forms the posterior leaf of that structure. The *ovarian ligament* extends



from the lateral and posterior portion of the uterus, just beneath the tubal insertion, to the uterine or lower pole of the ovary. It is usually several centimeters long and 3 to 4 millimeters in diameter. It is covered by peritoneum, and is made up of muscle and connective-tissue fibers, which are continuous with those of the uterus. The *infundibulo-pelvic* or *suspensory ligament* of the ovary extends from its upper or tubal pole to the pelvic wall. It represents the portion of the upper margin of the broad ligament which is not occupied by the tube, and through it the ovarian vessels gain access to the broad ligament.

For the most part the ovary projects freely into the abdominal cavity, and is not covered by peritoneum except near its hilum, where a narrow band may be observed which is continuous with the peritoneum covering the mesosalpinx. It follows, therefore, that over its lower portion only can be noted the glistening appearance characteristic of peritoneum, while the greater part of its surface is of a dull white color and looks moist. This distinction was discovered by Farre, but its importance was first emphasized by Waldeyer (Fig. 71), who showed that the ovary above the peritoneal line was covered by cuboidal epithelium.

In many of the lower animals the ovary does not project freely into the abdominal cavity, but is more or less completely inclosed in a peritoneal sac, into which opens the fimbriated end of the tube. In the cow, dog, and cat there is more or less free communication between the former and the peritoneal cavity.

The exterior of the ovary varies in appearance according to the age of the individual. In young women the organ presents a smooth, dull white surface, through which glisten a number of small, clear vesicles—the Graafian follicles. As the woman grows older it takes on a more corrugated appearance, which in the aged may become so marked as to be suggestive of the convolutions of the brain.

The general structure of the ovary can best be studied in cross-sections, when the organ is seen to be made up of two portions: the cortex and medulla, or *zona parenchymatosa* and *zona vasculosa*. The *cortex* or outer layer varies in thickness according to the age of the individual, becoming thinner with advancing years. In this layer the ova and Graafian follicles are situated. It is composed of spindle-shaped connective-tissue cells, through which are scattered primordial and Graafian follicles in various stages of development, which



FIG. 65.—CROSS-SECTION ADULT OVARY SHOWING GRAAFIAN FOLLICLES.  $\times 4$ .

become less numerous as the woman grows older. The most external portion of the cortex presents a dull whitish appearance, and is designated as the *albuginea*, though it is not analogous with the similarly named structure in the testicle; on its surface is a single layer of cuboidal epithelium—the ovarian epithelium of Waldeyer.

The *medulla* or central portion of the ovary is composed of loose connective tissue, which is continuous with that of the mesovarium. It contains large numbers of blood-vessels, both arteries and veins; and, according to His, Köllicker, and Rouget, a considerable number of non-striated muscle-fibers, whose presence caused the last-named observer to class it among the erectile tissues. The arrangement of the blood-vessels has been studied exhaustively by Clark, to whose admirable monograph we would refer those interested in the subject.

In the neighborhood of the hilum one occasionally observes short ducts or tubes, which are lined by a single layer of columnar epithelium. Their significance is not clear, and it is not known whether they represent remnants of the rete ovarii or of the Wolffian bodies.

In the human foetus collections of epithelial cells are frequently observed in the neighborhood of the hilum, which are arranged in masses or strands sharply marked off from the surrounding stroma. These are the medullary cords (Markstränge) of Köllicker, who believed that they represented portions of the Wolffian body which had become included within the ovary. The investigations of Coert, Winiwarter, and others show, however, that such is not the case, but that they represent the remains of the first proliferation of the germinal epithelium, and are analogous to the seminiferous tubules of the testicle. In early embryos the lower extremities of the medullary cords develop lumina which eventually communicate with the tubules of the epoophoron (rete ovarii) (Fig. 69). In the female this is only a transient phenomenon, and usually disappears before birth; while it persists in the male and affords a satisfactory explanation for the employment of the Wolffian ducts as efferent channels for the testicles. On the other hand, the medullary cords are persistent and characteristic structures in many of the lower animals.

Moreover, in many of the lower animals the medulla of the ovary is occupied to a variable extent by masses of characteristic epithelioid cells, somewhat resembling those making up the corpus luteum. Limon in 1901 called attention to their existence, and his findings were confirmed by Bouin, Aimé, and others. The origin of the cells is not clear, but, as they are supposed to take part in the formation of the internal secretion, they are sometimes designated as the interstitial gland of the ovary. The researches of L. Fraenkel and A. Schaeffer show that such structures are not present in the adult human ovary, and are not constant in the lower animals, being present in certain species, but absent in others which are closely related. This being the case, it is evident that the "interstitial gland" is not essential to the production of the internal secretion of the ovaries.

The nerves of the ovary are derived in great part from the sympathetic plexus which accompanies the ovarian artery, while a few are derived from



the plexus surrounding the ovarian branch of the uterine artery. Their finer anatomy, after they enter the ovary, has been studied by numerous investigators, among whom may be mentioned Von Herff, Gawronsky, Mandl, Winterhalter, and Vallet. The consensus of these researches shows that the ovary is very richly supplied with non-medullated nerve-fibers, which for the most part accompany the blood-vessels, and are merely vascular nerves; whereas a few form wreaths around the follicles and give off many minute branches, which have been traced up to, but not through, the *membrana granulosa*.

Elizabeth Winterhalter has described a collection of ganglionic cells in the medulla of the ovary which she designates as the ovarian ganglion. She believes that these cells play an important part in the production of menstruation, although the majority of investigators do not share her views.

**Accessory Ovaries.**—Waldeyer, in 1870, directed attention to the occasional presence of accessory bodies which are sometimes found on the broad ligament in the neighborhood of the main ovary. These structures are usually small, although in rare instances they may attain a considerable size. Occasionally they result from faulty development, but more frequently are to be attributed to inflammatory changes occurring during fetal life, as a consequence of which small portions of the ovary have been cut off from the body of the organ. The subject has been considered in detail by Engström, Thumin, Seitz, and Chiari, and cases have been described in which there was found a typical third ovary connected with the uterus by a separate tube.

**Transplantation of Ovaries.**—Experimental studies undertaken by Grigorieff, Knauer, Marshall, and others have shown that the ovaries of animals and women may be excised from their original position and transplanted to other portions of the body, or even into other animals of the same species, and that in their new situation they can establish vascular connections and continue their functional activity. Pregnancy has repeatedly followed such operations in animals, and Morris states it has even occurred in women. For full literature upon the subject up to 1908 the reader is referred to the article of F. H. Martin.

**Internal Secretion.**—From the time that Brown-Séquard published his studies upon the internal secretion of the testicles, it has been more or less generally believed that the ovaries likewise elaborate a somewhat analogous product, which plays an important part in the female economy. Indeed, the work of Knauer, Mandl, Bürger, and others indicates that this secretion is directly concerned in maintaining the integrity of the other generative organs; inasmuch as they have shown that atrophy of the uterus and vagina rapidly follows the removal of the ovaries, whereas this does not occur when they are removed from their normal position and transplanted to other portions of the body. They therefore conclude that in such cases the absence of atrophy must be attributed to the action of the internal secretion of the transplanted ovaries, since all nerve connections were severed at the time of operation.

Fränkel in 1903, and again in 1910, as the result of ingenious experi-

ments and clinical work, stated that the internal secretion is elaborated in the corpus luteum; though his teachings have not obtained universal acceptance. Furthermore, many believe that the "interstitial gland" plays

an important part in its elaboration, but, as this structure is lacking in human ovaries, such a supposition is untenable at least so far as women are concerned. Upon these ideas is based the therapeutic application of tablets composed of desiccated tissue from the entire ovary or solely from the corpus luteum.

**Development of the Ovary.**—An accurate idea of the structure of the ovary can be gained only through the study of its development. To Waldeyer we are indebted for much of our knowledge concerning the subject, though important preliminary work had been done by Valentin and Pflüger.

In 1870 Waldeyer pub-

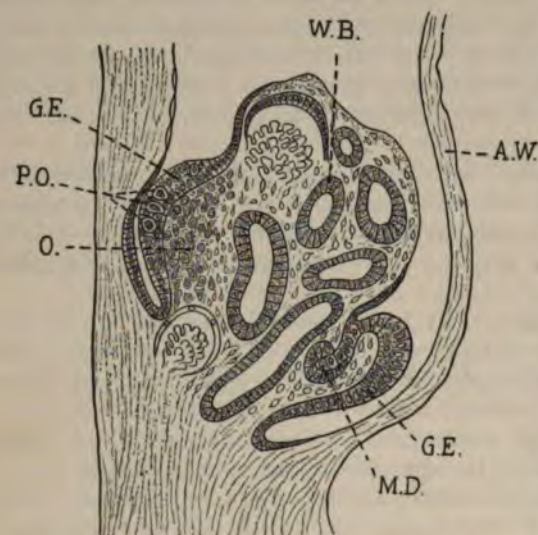


FIG. 66.—SECTION THROUGH WOLFFIAN BODY AND BEGINNING OVARY AND MÜLLERIAN DUCT (Waldeyer).  
× 160.

A.W., abdominal wall; G.E., germinal epithelium; M.D., beginning Müllerian duct; O., beginning ovary; P.O., primordial ova; W.B., Wolffian body.

lished his monograph upon the Ovary and Ovum (*Eierstock und Ei*), which was based in great part upon the embryology of the chicken. He found that by the fourth day of development the coelomic epithelium covering the inner surface of the Wolffian body is differentiated from the surrounding tissue, its cells becoming larger and more cuboidal in shape, and some of them assuming a considerable size. Within a short time the epithelium proliferates to such an extent as to form a distinct elevation, which indicates the situation of the future ovary (Fig. 66). This epithelium Waldeyer designated as *germinal epithelium*, and the large, clear cells found within it as *primordial ova*. As the proliferation continues, a mass of cells is formed consisting of large primordial ova and smaller epithelial cells. By the upward growth of the connective tissue and blood-



FIG. 67.—SEX GLAND OF PIG EMBRYO, 1.2 CM. LONG (Skrobansky).



vessels from the Wolffian body, the epithelial masses become divided into smaller portions, the so-called egg-nests or Pflüger's tubes, which in turn become broken up into smaller and smaller masses, until eventually isolated primordial ova are found, which are surrounded by a single layer of more or less flattened epithelium. These represent the primordial follicles.

Waldeyer in 1901, however, stated that the process was not so simple as he had originally believed, and the work of Nagel,

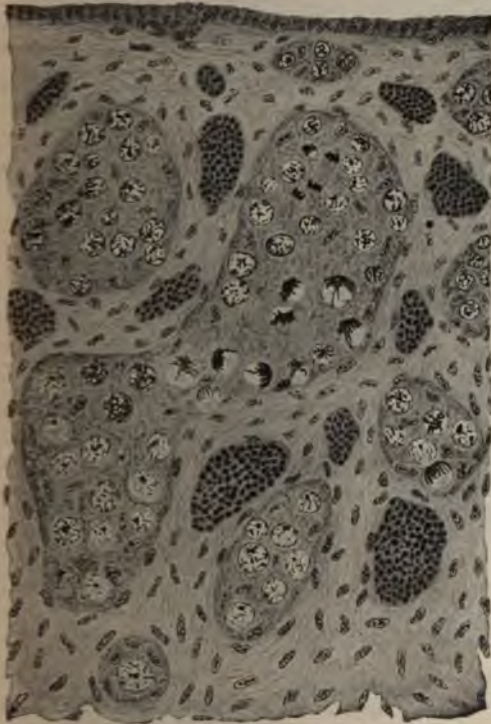


FIG. 68.—CORTEX OF PIG EMBRYO, SHOWING GERMINAL EPITHELIUM, PFLÜGER'S TUBES WITH OOCYTES IN VARIOUS STAGES OF DEVELOPMENT (Skrobansky).

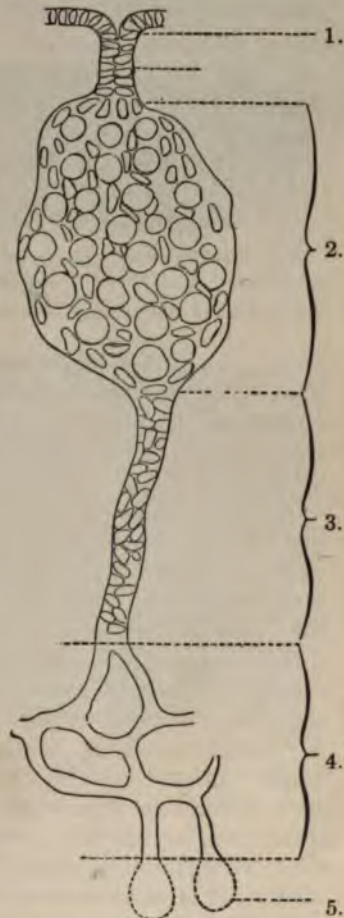


FIG. 69.—DIAGRAM SHOWING FORMATION OF OVARY (Winiwarter).

1, germinal epithelium; 2, germ tube; 3, medullary cord; 4, rete ovarii; 5, epooophoron.

Wendeler, Winiwarter, Skrobansky, and McIlroy clearly shows that in the higher animals, at least, the process of development is quite different.

In either sex, the first trace of the sexual glands is found in a thickening of the epithelium on the inner surface of the Wolffian body. These primitive sex cells rapidly proliferate and give rise to a distinct elevation, which is made up of closely packed undifferentiated epithelial cells and covered by a single layer of cuboidal cells arranged perpendicularly to the

surface of the mass. The latter correspond to the future ovarian epithelium and take no part in the formation of ova and follicles (Fig. 67).

The cells of the primitive sex gland proliferate rapidly and invade the underlying stroma of the Wolffian body, so that a cortical and medullary portion can be distinguished at an early period. The epithelial cells soon

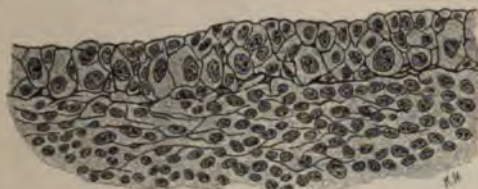


FIG. 70.—SECTION THROUGH THE OVARY OF A PIG EMBRYO (Nagel).

G.E., germinal epithelium; S., stroma of Wolffian body.

become broken up into irregular masses by the up-growth of connective tissue and have little or no connection with the surface epithelium. The most deeply lying cells do not become differentiated, but extend downward as the medullary cords. The more superficial cells, however, continue to

proliferate, and soon show signs of differentiation, which progresses from below upward. Many retain their original appearance, while in others the nucleus becomes larger and clearer, and its chromatin arranged in a different manner. These latter cells are the oogonia, from which the ova are to be developed.

After a certain period the oogonia cease proliferating, when the resulting cells become larger, and their chromatin undergoes a series of complicated changes, which eventually lead to the formation of the reticulated nucleus of the primordial ovum or oocyte of the first order (Fig. 68). By the continued growth of connective tissue the masses of oocytes and undifferentiated epithelial cells become still further broken up, so that eventually each oocyte is surrounded by a single layer of flattened cells, thus giving rise to a primordial follicle.

That there is no essential difference between the differentiated and undifferentiated cells is shown by the fact that the cells of the medullary cord, which are of the latter variety, may develop into typical oocytes; these, however, do not give rise to primordial follicles, but degenerate *in situ*. It would thus appear that the primordial ova or oocytes do not develop from the surface epithelium, but rather from the undifferentiated cells of the primitive sexual glands.

This process has been observed in rabbits, pigs, and human beings by all recent investigators. For full information the student is referred to the works of Waldeyer, Winiwarter, Skrobansky, and Mellroy.

The ovary, therefore, in its earliest stages, consists of two layers, a single layer of germinal epithelium covering an underlying connective tissue (Fig. 70). In human beings the formation of oocytes ceases before birth, but in some of the lower animals, especially in the bat, the process continues throughout life. In the greater part of the ovary consists of the cortex, which is a layer of closely packed primordial follicles, which are separated from the medulla by very thin bands of connective tissue, although occasionally some of the follicles may be in direct contact (Figs. 71 and 72). At



this period the surface of the ovary is covered by a single layer of cuboidal epithelium which shows no signs of proliferation.

All authorities agree that the oocytes or primordial ova are derived from the germinal or sexual epithelium, but there is still considerable discussion as to the origin of the epithelium surrounding them. According to Waldeyer and the majority of other observers, the *follicular epithelium* is derived from the cells of the germinal epithelium, which has not been converted into oocytes. Köllicker, on the other hand, believed that it originated from the epithelium of the Wolffian bodies, and that the medullary cords in the adult ovary represented portions of the Wolffian body which were not utilized in this way. Foulis, in 1878, stated that the so-called follicular epithelium was derived from the connective tissue of the ovary,

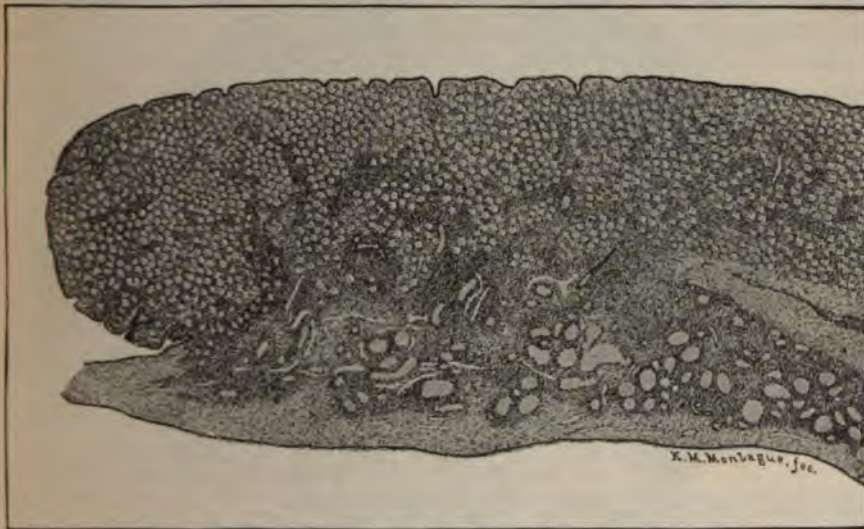


FIG. 71.—OVARY OF NEW-BORN GIRL.  $\times 22$ .

and the more recent studies of Wendeler and Clark would seem to confirm this view. Clark bases his conclusions upon his observation that the cells surrounding the primordial follicles are spindle-shaped and differ but little in appearance from the adjacent stroma cells; and more especially upon the fact that in the earlier stages of the ovary many of the oocytes are not surrounded by epithelium at all, but are in direct contact with the surrounding connective tissue.

Waldeyer's view, however, has obtained almost universal acceptance, and is placed beyond all reasonable doubt by the work of Winiwarter and McIlroy, so that it would seem advisable to dismiss Foulis's theory as untenable.

In rare instances the surface epithelium of the ovary may be ciliated, and now and again, as has been pointed out by Von Velits and myself, the follicular epithelium may likewise be found to possess cilia. These

observations, in spite of their rarity, speak strongly against the connective-tissue origin of the follicular cells.

**Microscopic Structure of Ovary.**—From the first stages of its development until after the menopause the ovary is undergoing constant change. According to Waldeyer, each ovary at birth contains at least 100,000 oocytes, the majority of which disappear before the age of puberty; so that at that time only 30,000 to 40,000 remain. The changes concerned in their disappearance will be considered more fully when we consider the corpus luteum.

Before taking up the consideration of the evolution of the mature follicle, it may be well to mention certain historical points in connection



FIG. 72.—OVARY AT BIRTH, SHOWING PRIMORDIAL FOLLICLES.  $\times 300$ .

with it. The Graafian follicle was first described in 1672 by De Graaf, a physician of Delft, who not only observed the vesicles, but demonstrated the presence of ova in the tubes of rabbits. The human ovum was first recognized by Von Baer in 1827, its nucleus or germinal vesicle by Purkyne in 1830, and its nucleolus or germinal spot a few years later by Wagner.

In 1891 Boveri pointed out that the nomenclature usually employed in connection with the specific cells of the ovary was faulty. He contended that the terms ovum and egg are synonymous, and should therefore be restricted to cells which are ready for fertilization. As this is the case only after the completion of maturation and the casting off of the polar bodies, he suggested that other terms be employed prior to that period. Accordingly, he designated the cells during the stage of division as oogonia,



from then until maturation begins as oocytes of the first order, after the formation of the first polar body as oocytes of the second order, and as ova or ovia only after the formation of the second polar body.

In the young child the greater portion of the ovary is composed of the cortex, which is filled with large numbers of closely packed primordial follicles, those nearest the central portion of the ovary showing the most advanced stages of development. As was mentioned above, the majority are destroyed before the time of puberty, and Stevens has given an exhaustive account of the process.

In young women the cortex contains large numbers of primordial follicles separated by thicker or thinner bands of connective tissue, which is made up of cells with spindle-shaped or oval nuclei. Each primordial follicle consists of an oocyte and its surrounding epithelium. The oocyte is a single cell, more or less round in shape, with a clear protoplasm and a tolerably large nucleus occupying its central portion. The nucleus presents a marked reticulated network and at one point a well-defined nucleolus, as well as numerous accessory nucleoli, which are formed at the intersections of the nuclear thread-work.

According to Nagel, the oocyte remains constant in size from birth until the transformation of the primordial into the typical Graafian follicle, no matter at what period of life this change may occur. These oocytes measure from 48 to 69 microns, and their nuclei from 29 to 32 microns in diameter. The primordial ovum, or oocyte of the first order, is surrounded by a single layer of small, spindle-shaped epithelial cells, which are somewhat sharply differentiated from the still smaller spindle-shaped cells of the surrounding stroma (Fig. 73).

Occasionally a primordial ovum may contain two nuclei or germinal vesicles, as has been shown by Nagel, Klein, von Franqué, and others. Again, occasionally two and sometimes three distinct ova may be found in a single primordial follicle, and it is from such structures that multiple pregnancies were formerly supposed to develop.

When, under the influence of factors with which we are as yet unacquainted, the primordial follicle begins to develop, we notice in the first place that its epithelium becomes converted into a single layer of cuboidal cells (Fig. 73). Nuclear figures soon make their appearance, and the cells begin to proliferate rapidly, so that in a very short time the ovum becomes surrounded by a number of layers of epithelial cells. Certain of these cells undergo degeneration, and vacuolated areas are not infrequently observed between them. This process continues until a considerable

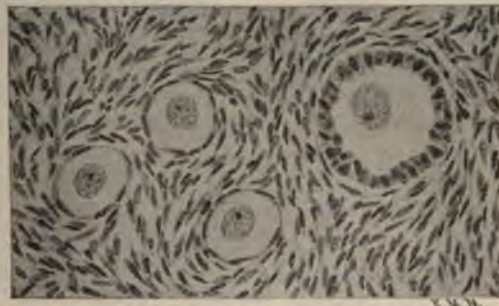


FIG. 73.—OVARY OF YOUNG WOMAN, SHOWING PRIMORDIAL FOLLICLES ON LEFT SIDE AND FOLLICLE JUST BEGINNING TO DEVELOP ON RIGHT.  $\times 210$ .

portion of the follicle is filled with fluid, which is formed partly by the degeneration of the follicular cells and partly by transudation from surrounding vessels.

Coincident with the development of the fluid, the so-called *liquor folliculi*, the ovum becomes pushed to one side of the follicle, where it is surrounded by a mass of cells—the *discus proligerus* or *cumulus*

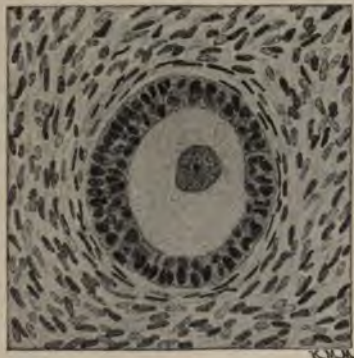


FIG. 74.—DEVELOPING FOLLICLE.  
X 210.

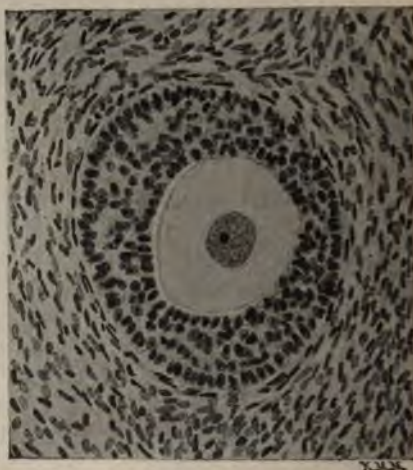


FIG. 75.—DEVELOPING FOLLICLE.  
X 210.

*oophorus*—while the rest of the epithelium is arranged in a number of layers around the interior of the follicle, and is known as the *membrana granulosa* (Fig. 76).

While these changes are taking place, the ovum itself becomes larger, important changes take place in its nucleus preparatory to the formation of the first polar body, yolk granules or deutoplasm are deposited in its protoplasm, and a thin, transparent structure—the *zona pellucida*—appears about its periphery. At the same time, the stroma immediately surrounding the growing follicle becomes vascular, and its cells show marked evidences of proliferation. The *membrana granulosa* is separated from the stroma by a thin basement membrane consisting of a single layer of flattened, spindle-shaped, connective-tissue cells. Just between the basement membrane and the outermost layer of the *membrana granulosa* there not infrequently appears a thin, transparent layer, which was first described by Grohe and Slavjansky. This, no less than the *zona pellucida*, is a species of exudate from the *granulosa* cells.

**Mature Graafian Follicle.**—From birth until the cessation of sexual life Graafian follicles are constantly being developed. Before the age of puberty they are found only in the deeper portions of the cortex, and do not reach the surface of the ovary; later, however, they develop in the superficial portions of the cortex and make their way to the surface, where they appear as transparent vesicles, varying from 2 or 3 to 10 or 15 millimeters in diameter. As the follicle approaches the surface of the ovary its walls become thinner and more abundantly supplied with vessels, except



in its most prominent projecting portion, which appears almost bloodless and is designated as the *stigma*, the spot where rupture is to occur.

The mature Graafian follicle consists of a connective-tissue covering—the *theca folliculi*; an epithelial lining—the *membrana granulosa*; the ovum, and the liquor folliculi. The *theca folliculi* is readily divided into two layers: an outer, the *tunica externa*, and an inner, the *tunica interna*.



FIG. 76.—NEARLY MATURE FOLLICLE.  $\times 210$ .

*D.*, discus proligerus; *M.G.*, membrana granulosa; *T.ex.*, tunica externa; *T.int.*, tunica interna.

The tunica externa consists of the ordinary ovarian stroma, which is arranged concentrically about the follicle, while the connective-tissue cells of the tunica interna have undergone marked changes.

Almost as soon as the primordial follicle shows signs of development, nuclear figures appear in the stroma immediately surrounding it, and a considerable multiplication of cells occurs. These become considerably larger than the surrounding connective-tissue cells, and as the follicle increases in size assume a granular appearance, which is due to the presence of a yellowish pigment. These cells are designated as *lutein cells* and, as will be seen later, play an important part in the formation of the corpus luteum. In most hardened specimens the coloring matter has been dissolved out, and the cells appear not unlike those of the suprarenal capsules (see *T. I.*, Fig. 77). At the same time there is a marked increase in

the vascularity of the theca, and numerous lymphatic spaces make their appearance.

The epithelial lining of the follicle, or *membrana granulosa*, consists of a number of layers of small polygonal or cuboidal cells, with round, darkly staining nuclei, which are arranged in fewer layers the larger the follicle. At one point the *membrana granulosa* is much thicker than elsewhere, and



FIG. 77.—SECTION THROUGH WALL OF MATURE FOLLICLE. (Highly magnified).

M.G., *membrana granulosa*; T.I., *tunica interna*; T.E., *tunica externa*.

forms a more or less pyramidal mound in which the ovum is included. This is the *discus proligerus* or *oophorus*, and is usually situated at the portion of the follicle farthest removed from the surface of the ovary (see Fig. 76). The follicle is filled with a clear, albuminous fluid, the *liquor folliculi*, which is partly the product of the degenerated follicular epithelium and partly a transudate from surrounding vessels. As the follicle approaches its highest development, marked alterations appear in the follicular epithelium, which by appropriate methods can be demonstrated as due to fatty degenerative changes.

The ovum becomes much larger as it approaches maturity, and, according to Nagel, measures from 150 to 250 microns ( $1/5$  millimeter) in diameter, as compared with 48 to 69 microns in its primordial condition; while Jackson estimates that it weighs 0.000004 grams.

If the nearly *mature ovum* be examined in the liquor folliculi or in normal salt solution, the following structures, according to Nagel, may be distinguished in and about it: (a) a corona radiata; (b) a zona pellucida; (c) a perivitelline space; (d) a small, clear zone of protoplasm; (e) a broad, finely granulated zone of protoplasm; (f) a central, deutoplasmic zone; and (g) the germinal vesicle with its germinal spot.



The *corona radiata* consists of a number of layers of follicular epithelium which adhere to the ovum, and was so designated by Bischoff, by whom it was first described. Inside of the corona radiata comes a narrow, transparent zone—the *zona pellucida*—which is a product of the granulosa cells, and does not belong to the ovum itself. Separating the ovum from the zona pellucida is a clear, narrow space, the *perivitelline space*, within which the ovum is freely movable, so that no matter what position it may assume its germinal vesicle will always point upward. Inside of the perivitelline space is the ovum proper, which differs markedly from the primordial oocyte, not only by its increased size, but more especially by the presence of a yolk or deutoplasm which fills the greater part of its interior. The *deutoplasm* occupies the central portion of the ovum, and is made up of large numbers of irregularly shaped, highly refractive granules. As it develops it pushes the germinal vesicle to one side, so that the latter always assumes an eccentric position in the ovum.

Outside of the deutoplasm comes a narrow zone of finely granular protoplasm, which owes its peculiar appearance to the presence of very small yolk-granules; external to this, again, is a still narrower zone of clear protoplasm.

The *germinal vesicle* presents a distinct reticular, nuclear network, the intersections of which appear as very darkly staining points. The nucleolus or *germinal spot* is much larger than in the primordial ovum, and according to Auerbach presents amoeboid movements.

An ovum presenting the above characteristics is generally described as mature, but is not capable of fertilization and further development until it has undergone certain changes, which are designated as maturation, and manifested by the formation and casting off of the polar bodies.

Graafian follicles, as we have already pointed out, develop throughout childhood, and occasionally attain a considerable size; but they rarely rupture at this time on account of their position in the depths of the ovary and the intervention of a thick layer of cortex between them and the surface. In adults, on the other hand, the developing follicle makes its way to the surface, and when it has attained its highest development ruptures and extrudes its ovum into the peritoneal cavity or the tube, where it may be fertilized.

Formerly it was believed that *rupture of the follicle* was brought about by the increased tension resulting from the rapid formation of the liquor folliculi, which, according to Nagel, was markedly accentuated by the pressure exerted by the lutein cells developing about its periphery. Clark, however, has shown that rupture of the follicle is a complex process, and is due primarily to circulatory changes. As the period of ovulation approaches, the ovary becomes engorged with blood and, the intra-ovarian tension being markedly increased, the growing ovum is forced to the surface; at the same time the circulation in the most distended portion of the wall of the follicle is interfered with, whence results necrosis at the point designated as the stigma, which eventually gives way.

**Corpus Luteum.**—The corpus luteum is a structure which is formed at the site of a ruptured follicle. When the mature follicle ruptures, the

ovum, liquor folliculi, and a considerable portion of the degenerated membrana granulosa make their escape, and the walls of the empty follicle collapse. In a short time, however, its cavity becomes filled with blood, which is derived partly from the vessels at the point of rupture, but principally from those of the tunica interna of the theca.

The corpus luteum, therefore, in its earliest stages is simply a ruptured follicle filled with blood, outside of which is a narrow yellow ring formed by the lutein cells of the theca. These, however, proliferate rapidly and invade the blood-filled follicle, forming a festooned layer about its central blood-clot (Fig. 78). This layer is yellowish in color, whence the

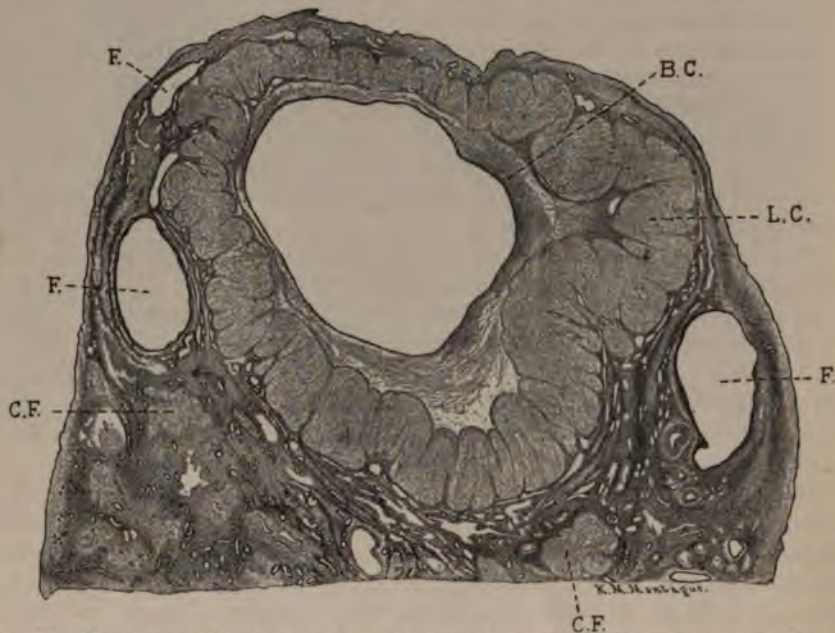


FIG. 78.—PORTION OF OVARY, SHOWING A CORPUS LUTEUM OF PREGNANCY, WITH CYSTIC CENTER.  $\times 4$ .

B.C., blood-clot; C.F., corpus fibrosum; F., Graafian follicles; L.C., lutein cells.

term "corpus luteum." As the structure becomes older, the yellow ring becomes thicker and thicker, until at last it almost entirely fills the interior of the follicle, the central blood-clot remaining being now quite small.

At its greatest development the corpus luteum is always larger than the original follicle, and not infrequently occupies a considerable portion of the ovary, sometimes as much as one-third of the entire organ.

Microscopic sections through a well-developed example show that its center is occupied by a compressed blood-clot, immediately outside of which is a thin layer of newly formed connective tissue. The greater part of the structure, however, is occupied by the festooned yellow ring, which is made up of large, polygonal, epithelioid cells, with small, round, somewhat faintly staining nuclei. These are the *lutein cells*, whose protoplasm has



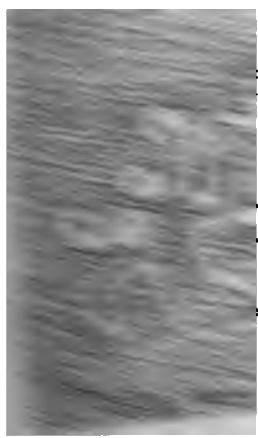
taken on a granular appearance due to the presence of a peculiar yellow pigment which is soluble in chloroform, alcohol, and ether. The layer of lutein cells is traversed by numerous radiate, tolerably thick, connective-tissue partitions, to which it owes its festooned appearance. They are richly supplied with blood-vessels and lymphatics (Fig. 79).



FIG. 79.—SECTION THROUGH YELLOW LAYER OF CORPUS LUTEUM, SHOWING LUTEIN CELLS.

As the cavity of the follicle is encroached upon by the growing lutein cells, the blood-clot becomes more and more compressed, and vascular loops extend into it and soon cause its organization. At the same time, the blood pigment is removed by leukocytes, which can be found in the surrounding tissue with their bodies filled with particles of it. Occasionally hæmorrhage does not take place into the ruptured follicle, and a corpus luteum is formed without a central blood-clot. This is the exception in human beings, but the rule in many of the lower animals, as in the rabbit and mouse.

After the cavity of the follicle has become obliterated by the ingrowth of the lutein cells and connective tissue, degenerative changes soon make their appearance in the former, some of which undergo hyalin and others fatty degeneration. In young women, in whom the circulation is active, the degenerated lutein cells are rapidly absorbed, so that in a short time the corpus luteum becomes replaced by newly formed connective tissue which corresponds closely in appearance to the surrounding ovarian stroma. But in more advanced life, when the ovarian circulation has become impaired, absorption goes on less rapidly; and not infrequently the degeneration extends to the intervening connective tissue and blood-vessels until the entire structure is converted into an almost homogeneous mass of hyalin in which only a few connective-tissue cells and degenerated blood-vessels can be seen (Fig. 80). These structures—the so-called *corpora fibrosa* or





nective-tissue origin and represent the cells of the theca interna. This view was first advanced by von Baer, and has been confirmed by the work of Köllicker, His, Beigel, Nagel, Clark, Waldeyer, Hegar, and many others. A number of authors, on the other hand, following the example of Bischoff, consider that they originate from epithelial cells derived from the membrana granulosa. This explanation has been advocated more particularly by Sobotta, and has received additional support from the work of Kreis, Cohn, Marshall, Meyer and others; while Loeb believes that they are partly of connective tissue and partly of epithelial origin. Full details of the discussion are contained in the papers of Clark, Sobotta, and Meyer. I shall content myself with giving the evidence in favor of the former view.

The connective-tissue origin of the lutein cells is based upon two facts: first, the cells of the tunica interna of the theca begin to undergo marked changes as soon as the follicle commences to develop; and secondly, the membrana granulosa presents extensive degenerative changes, and is usually cast off in great part at the time of rupture.

In the early stages of follicular development, the cells of the theca interna become larger and assume an epithelioid appearance. Nuclear figures soon appear and rapid proliferation ensues. At the same time their protoplasm becomes more granular, and pigment is deposited within them, so that they closely resemble the lutein cells. That they first appear in the theca would argue against their derivation from the membrana granulosa, but even more so the fact that they are separated from it by a definite barrier of unchanged connective tissue, the upper layer of which forms the basement membrane of the follicle (see Figs. 77 to 79).

The mature follicle, then, is surrounded by actively proliferating lutein cells, while its membrana granulosa shows signs of fatty degeneration. In many instances, before rupture, a narrow yellow ring may be found surrounding the periphery of the follicle, from which it is separated by a thin layer of connective tissue. As soon as the follicle ruptures the lutein cells proliferate more rapidly and, with the vessels included between them, speedily invade the follicular cavity.

Observations based upon the study of many hundred human corpora lutea have convinced me that the connective-tissue origin of the lutein cells is established beyond all reasonable doubt. Strong support in favor of this view is also to be obtained from the changes which are observed in follicles which develop in the deeper portions of the ovary, and degenerate without rupture. This process has been studied by a number of observers, notably Slavjansky, Schottländer, Clark, and others, and is designated as *follicular atresia*. In such circumstances, precisely the same changes are observed as in the formation of the corpus luteum, except that hæmorrhage is absent and that the process is less marked. In many instances the entire membrana granulosa is separated from the walls of the follicle, and lies free in its cavity, presenting marked signs of fatty degeneration, while the cells of the theca are actively proliferating and are being converted into lutein-like cells. Moreover, the spontaneous involution of the large lutein cell cystomata, which frequently accompany hydatidiform moles, would seem to offer additional evidence in favor of the connective-tissue

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in a medico-legal case that a woman had been pregnant, because a corpus luteum was found in one ovary. Even after the more frequent performance of autopsies, and the closer attention directed to the condition of the ovaries had led to the abandonment of this view, it was for a time believed that the presence of corpora lutea indicated that the individual had indulged in sexual relations, or had at least been under marked sexual excitement. Finally, as a result of the work of Bischoff, Raciborski, Négrier, and Pouchet (1840-47), it was definitely established that the corpus luteum was not necessarily a sign of pregnancy, but occurred after each menstrual period in virginal as well as married women. For fuller information on this point the works of Montgomery and Dalton may be consulted.

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## SECTION II

### *PHYSIOLOGY AND DEVELOPMENT OF THE OVUM*

#### CHAPTER III

##### **MENSTRUATION AND OVULATION—MIGRATION OF THE OVUM AND PLACE OF MEETING OF OVA AND SPERMATOZOA**

**Menstruation.**—By menstruation we understand a process characterized by a discharge of blood from the genitalia, which recurs at regular intervals, except during pregnancy and lactation, from the time of puberty until the menopause. Ordinarily it comes on every four weeks and lasts from three to five days, though there are marked individual variations as to its frequency and duration.

The age at which the menses are established varies in different countries, being earlier in warm and later in cold climates. In the temperate zone the first menstruation does not usually occur before the fourteenth or fifteenth year. Not a few instances of a much earlier appearance of the function, however, are to be found in the literature, and are usually associated with precocious sexual development. One of the most notable cases of this character is that of Anna Mummenthaler, who, according to Haller, menstruated regularly from her second year, and gave birth to a full-term child at the age of nine.

Frequently a bloody vaginal discharge is observed in new-born infants, which ceases after a few days, no further discharge being noted until puberty. To describe these as instances of precocious menstruation, however, would be incorrect; more particularly as Halban attributes the loss of blood, as well as the occurrence of milk in the breasts of infants, to the circulation of some substance probably derived from the placenta.

In this country the menopause usually occurs about the forty-fifth year. In rare instances, however, the menstrual flow may cease as early as the twenty-eighth or thirtieth year, while occasionally it continues until well into the fifties, or even until a later period. Thus, Kennedy reports the case of a woman who gave birth to her twenty-second child when she was sixty-three years old, after which she still continued to menstruate. For various interesting historical and ethnological data concerning menstruation, the reader is referred to the works of Ploss and Ottokar Alt.

The menstrual flow is derived from the uterine mucosa, and consists of blood mixed with mucus, which, in ordinary circumstances, will not

coagulate. According to Schickele this is due to substances formed in the uterine tissues, as the fluid expressed from the uterus under high pressure inhibits coagulation when added to normal blood. Moreover, Bell has shown that the menstrual discharge is rich in calcium, while at the same time its amount in the circulating blood is diminished. Hoppe-Seiler states that the quantity of blood lost at each menstrual period is greatly overestimated and rarely exceeds 37 cubic centimeters. He arrived at this conclusion by soaking in water all the napkins used by the women, and determining the amount of hæmoglobin in the solution.

**Anatomical Changes in Menstruation.**—The statements concerning the extent of the changes occurring in the endometrium during menstruation are very contradictory. Sir John Williams believes that the entire mucosa is cast off at each menstrual period, while Moericke and numerous other observers state that there is little or no destruction of tissue. Between these extremes we find a number of authors stating that a greater or lesser portion undergoes disintegration. Generally speaking, the older authorities held that the entire mucosa, or at least a considerable part of it, was cast off. Their adoption of this view is probably explained by the fact that their conclusions were drawn from the study of uteri in which post-mortem changes had taken place, since De Sinéty was the only observer among those whose work was based upon autopsy specimens who held a contrary opinion.

In 1882, Moericke stated that menstruation was accompanied by little or no destruction of tissue, basing his statements upon the examination of 45 specimens of the menstruating endometrium which he obtained by curettage. His views were soon confirmed by other observers, among whom may be mentioned De Sinéty, Löhlein, Westphalen, Strassmann, Gebhard, and Findley. Meerdevoort and Mandl consider that the extent to which the tissue is destroyed varies within wide limits, the loss being almost imperceptible in some individuals and quite marked in others; while Kahlen and Christ believe that the destruction is always considerable.

Plate III, which represents a section through the endometrium of a uterus removed on the third day of menstruation, shows very distinctly that but little destruction of tissue has occurred. The entire mucosa is markedly thickened, and its superficial portion is infiltrated with blood. The surface epithelium is intact, but in places it has been separated from the underlying tissue by small collections of blood—the so-called sub-epithelial hæmatomata of Gebhard. The uterine glands are markedly hypertrophied, as is shown by their twisted and corkscrew-like course; this hypertrophy is associated with a considerable increase in the interglandular tissue, the cells of which, however, do not appear to have undergone changes in shape. There is marked engorgement of the blood-vessels, and just beneath the surface epithelium may be seen capillaries which are distended almost to the point of bursting, while considerable quantities of blood have escaped from the vessels and lie free in the tissues.

From this and similar observations, I have no hesitation in adopting the views of Moericke and his supporters, and in stating that menstruation is usually not attended by any great loss of tissue, but consists essentially

in marked hypertrophy of the mucosa, engorgement of its superficial vessels and the consequent escape of blood, partly following rupture, but in great measure by diapedesis. After the flow has ceased, a certain amount of degeneration takes place in the superficial layers of the mucosa, which, however, is soon repaired, nuclear figures appearing in the cells of the epithelium and interglandular tissue, which begin to multiply and replace the degenerated cells, so that regeneration is rapidly effected.

As menstruation occurs every twenty-eight days, it is apparent that the endometrium is subjected to an almost continuous change, the process being described as the *menstrual cycle*. This covers a period of sixteen days, five of which are needed for the preliminary swelling, four for the menses proper, and seven for the period of regeneration, so that the endometrium remains quiescent only about twelve days in each month. The researches of Hitschmann and Adler have still further accentuated these facts, and have clearly shown that during the period of premenstrual swelling the structure of the endometrium closely approaches that of an early decidua. Furthermore, Wegelin has shown that large quantities of glycogen appear with the approach of each menstrual period and disappear immediately afterwards, which he considers as a provision for the nutrition of the early ovum.

Heape, Marshall, and others have studied the anatomy of the œstrous cycle in monkeys and many other animals, and recognize the following stages:

|                                    |             |
|------------------------------------|-------------|
| 1. Period of rest                  | Anœstrum    |
| 2. Period of growth and congestion | } Proœstrum |
| 3. Period of destruction           |             |
| 4. Period of recuperation          |             |
|                                    | { Estrus    |
|                                    | { Metœstrum |

They hold that the sexual period in animals, or "rut," consists of two stages: the proœstrum or period of congestion and bloody discharge, and the œstrus or period for sexual intercourse, and conclude that menstruation in women and monkeys is analogous to the proœstrum in lower animals.

**Relation between Menstruation and Ovulation.**—By ovulation we understand the rupture of a mature Graafian follicle and the extrusion of the ovum. The relation between menstruation and ovulation has given rise to a great deal of controversy, and, while many interesting facts have been added to our information, it must be conceded that the subject is still far from being satisfactorily understood.

The fact that young girls do not usually conceive until after the appearance of the menses, and the extreme rarity of impregnation after their cessation, rendered it natural for the earlier observers to suppose that conception could not occur without menstruation, and that the menstrual flow represented the female semen. This view, however, was soon abandoned, and the discharge was regarded as a process of purification.

It was not until the doctrine of periodical ovulation had been established by the work of Gendrin, Negrier, Bischoff, Pouchet, and others that definite ideas could be formulated concerning the relation between ovula-



PLATE III.



SECTION THROUGH ENDOMETRIUM ON THIRD DAY OF MENSTRUATION.

× 52.

*B.*, blood; *B. G.*, gland filled with blood; *Ep.*, surface epithelium; *G.*, hypertrophied glands;  
*S.*, stroma.



tion and menstruation. From then on, however, it has generally been believed that menstruation was brought about by the ripening of the Graafian follicles, and that the two processes occurred almost, if not quite, simultaneously.

This doctrine culminated in 1865 with the appearance of Pflüger's article upon the significance and cause of menstruation, in which he stated that the flow resulted from a reflex stimulation, which owed its origin to the pressure exerted by the growing follicle upon the nerves of the ovary. This theory obtained almost immediate acceptance, and for years was the predominant belief; upon it was based our method of calculating the expected date of confinement, the rule being to date the beginning of pregnancy from the last menstrual period.

Pflüger's theory, however, was somewhat shaken by the work of Leopold, Prochownik, and De Sinéty, whose careful studies of the condition of ovaries removed at operation proved conclusively that the two processes were not necessarily synchronous, but might occur quite independently of one another, and accordingly ovulation could not be considered the unvarying cause of menstruation. Clinical experience also lent further probability to this view, since it has shown that ovulation and subsequent pregnancy might take place without menstruation; as is demonstrated by the instances of conception occurring before the establishment of menstruation or after the menopause, as well as during lactation, when the menstrual flow is usually absent. Moreover, a few cases are recorded in which pregnancies had occurred in such rapid succession that menstruation did not occur for years. Ahlfeld has reported the case of a woman who gave birth to numerous children, but did not menstruate until her thirty-second year.

Sigismund, Löwenhardt, Löwenthal, and Aveling next advocated the theory that ovulation preceded menstruation, and that the latter was due to the failure of conception. Aveling designated the process as nidation and denidation, and considered that a *menstrual decidua* was formed each month for the reception of the fertilized ovum, and that if conception did not occur it degenerated and was cast off with the menstrual flow. The gist of these theories was tersely expressed by Powers in the dictum, "Women menstruate because they do not conceive." This view was also adopted by His and most embryologists as true, for a certain number of cases at least. They found on examining ova which were nominally of the same age, as estimated from the last menstrual period, that some presented a stage of development several weeks in advance of the others; they held, therefore, that this difference could be explained only by supposing that the former resulted from conception soon after the last menstrual period, and the latter from conception just before the first period missed. This view is also confirmed by the reproductive history of the orthodox Jewesses, who are noted for their fertility. According to their laws women are considered unclean during the entire menstrual period and the seven days following it, so that in them conception probably occurs shortly before the first missed menstrual period. Pinard in 1909 strongly advocated this view, which also seems to receive strong support from the recent work upon the structure of the endometrium, as well as from the fact that my experience



shows that practically three-fifths of the young women who are married in the middle of an inter-menstrual period, and who miss the succeeding flow, are delivered of children of normal size 280 days after the onset of the last period, or in less than nine calendar months after marriage.

Fraenkel stated that menstruation was due to the elaboration of an internal secretion by the corpus luteum, which regulates the blood supply of the uterus. In 1910 he still further elaborated this view, and, as the result of comparative study of the corpus luteum, concluded that ovulation usually occurs 19 days after the last period, and that the corpus luteum resulting from the rupture of that follicle attains its highest development during the following week and then gives rise to menstruation. It is interesting to note that Villemin in 1908 expressed somewhat similar views.

Between the years 1885 and 1907 Leopold and his co-workers, Mironoff and Ravano, carefully studied the condition of the normal ovaries removed at operation from 95 women whose menstrual history had been carefully noted. In 59 cases, or 62 per cent., they found that menstruation and ovulation were synchronous, while in 36 cases they were not. The following figures give the findings in the 24 cases which he studied with Ravano:

|                                         |          |
|-----------------------------------------|----------|
| Ovulation at beginning of menstruation, | 12 cases |
| “ later in menstruation,                | 2 cases  |
| “ shortly before menstruation,          | 4 cases  |
| “ between two periods,                  | 1 case   |
| “ without menstruation,                 | 3 cases  |
| Menstruation without ovulation,         | 2 cases  |

Leopold accordingly concluded that, while the two processes are usually synchronous, they are not always so, and that ovulation and consequently conception may occur at any time. Bryce and Teacher have arrived at similar conclusions from the study of the 11 youngest embryos described up to 1908. They hold with Heape and Marshall that menstruation corresponds to the proœstrum of lower animals, and do not consider that such a view is inconsistent with our clinical or anatomical knowledge; as they hold that the essence of the menstrual cycle is not the mere preparation of a menstrual decidua, but rather the formation of a new endometrium.

Gottschalk in 1910 reported a number of cases which clearly showed that conception and consequently ovulation may occur just after the last period; and one observation of my own affords striking proof of its possibility. Five days after a menstrual period I removed an ovarian cyst and repaired the outlet of a married woman. She remained in the hospital three weeks and missed the following period. As this was attributed to the operation, no attention was paid to it, but examination after a second period had failed to appear revealed a two months' pregnancy. She was delivered of a seven-and-a-half-pound child 280 days from the beginning of the period which occurred before she entered the hospital.

From the evidence before us, we must conclude that ovulation and menstruation usually occur about the same time, but that one not infrequently antedates the other by a few days, while in exceptional cases they



may occur quite independently; but in any event that the latter is absolutely dependent upon the presence of the ovaries.

Mary Putnam Jacobi, in 1876, advanced the so-called menstrual-wave theory, which has been accepted by Stephenson, Webster, Ott, Van de Velde, and others. According to this idea, the metabolic processes in women present a distinct rhythm, and gradually increase in intensity up to the time of the menstrual flow, when they suddenly drop and reach their lowest point; after this they gradually rise again to attain their maximum intensity just before the next menstrual period, thus indicating that the entire process is under some central control, and that neither menstruation nor ovulation is directly dependent upon one another, but upon some general and as yet unknown cause.

The results following various operations upon the genital tract tend to show that menstruation is dependent upon the presence of the ovaries, but that ovulation may take place without the presence of the uterus; as it is generally admitted that the complete removal of both ovaries, which necessarily stops ovulation, is always associated with cessation of the menses. On the other hand, the total removal of the uterus, while associated with abolition of the menstrual flow, exerts no effect upon ovulation, as is manifested by the regular occurrence of the so-called menstrual moulins.

A number of observers have attempted to show that menstruation may occur independently of ovulation, basing their contention upon the occasional continuance of menstruation after the removal of the ovaries. This conclusion, however, is fallacious, as in such cases either the ovaries had not been completely removed, or an accessory ovary was present. The now well-established fact that a very small portion of ovary will suffice for ovulation has been demonstrated by the occurrence, in rare instances, of pregnancy after the supposed removal of both ovaries by competent operators, cases of which have been reported by Gordon, Meredith, and others.

Such observations conclusively demonstrate the fallacy of the view advanced by Tait, Johnstone, and Savage, that menstruation is regulated by the so-called menstrual nerve, and that its persistence after operation was due to the fact that this nerve had not been included within the ligature.

Ordinarily, the Fallopian tubes take no part in the menstrual function, and in none of my specimens were there any traces of a bloody fluid in them. Occasionally, however, the tubal mucosa may share in the process, as has been shown by Thompson, who reported a case in which a pyosalpinx had ruptured through the abdominal wall, leaving a fistulous opening which did not heal, and through which a slight amount of bloody fluid exuded at each menstrual period.

**Migration of the Ovum.**—The mechanism by which the ovum gains access to the tube after escaping from the ruptured follicle is a question of extreme interest, and one which has given rise to a great deal of discussion. The process is readily understood in those animals in which the ovaries are more or less completely inclosed in a peritoneal sac into which the tube opens; but in women, and in animals in which the ovary projects freely into the peritoneal cavity, the question presents greater difficulties and has not as yet received a thoroughly satisfactory solution.

As we have already shown, the fimbriated extremity of the tube lies in the neighborhood of the ovary, but is not necessarily in direct contact with it, the only organic connection between the two structures being furnished by the *fimbria ovarica*, which is attached to the upper or tubal pole of the ovary.

Numerous theories have been advanced to explain the manner in which the ovum enters the tube. Rouget believed that the latter became engorged with blood at the menstrual period, and that, as a result of its becoming erectile, the fimbriæ applied themselves to the portion of the ovary in which the ripe follicle was situated—so that, after its rupture, the ovum was immediately taken up by the fimbriated extremity of the tube. This view, however, has been abandoned, as it is difficult to suppose that the tube could instinctively pick out the exact portion of the ovary to which it should apply itself. Kehrler believed that the ovum was ejected from the follicle at the time of rupture with sufficient force to be thrown directly into the fimbriated end of the tube. This, the so-called ejaculation, theory for a time enjoyed considerable vogue, but has likewise been abandoned.

At present it is generally believed that the cilia upon the fimbriated end of the tube give rise to a current in the capillary layer of fluid which lies between the various pelvic organs, so that the ovum, on escaping from the follicle, is taken up by the current and wafted toward one or the other tube, whence it is carried to the uterus. The correctness of this view has been substantiated by the experimental work of Pinner, Jani, and Lode. The former injected cinnabar and the latter the ova of ascarides into the peritoneal cavity of animals, and found that they made their way to the pelvis, where they were taken up by the tubes, through which they were carried to the uterus, and eventually appeared in the vagina. This experimental evidence is reinforced by the fact that in certain amphibians large tracts of the peritoneum become covered by a ciliated epithelium shortly before the time of ovulation. It is more than likely, however, that a considerable proportion of the ova which escape from the ruptured follicle fail to gain access to the tubes, and perish in the peritoneal cavity.

In 1844 Bischoff directed attention to the fact that not infrequently in animals possessing bicornuate uteri one finds that the corpora lutea are in one ovary, while the embryos are developed in the uterine horn on the opposite side. He supposed in such cases that the fertilized ova had come from the ovary in which the corpora lutea were found, and had made their way into the cornu of the opposite side, instead of into the one corresponding to the ovary from which they came. This process he designated as *migration of the ovum*.

The possibility of such an occurrence in women was first carefully studied by Kussmaul, who stated that it might be brought about in two ways: either by the ovum making a circuit through the pelvic cavity and thus gaining access to the opposite tube, or passing down one tube, traversing the uterine cavity, and then making its way up the opposite tube. The former he designated as external, the latter as internal, migration of the ovum.

*External migration of the ovum is not infrequently observed, whereas*



there is considerable discussion as to the possibility of the occurrence of internal migration. We are unable to ascertain how frequently external migration takes place in normal uterine pregnancies, though it is probably by no means rare. On the other hand, its occurrence has been repeatedly demonstrated in cases of bicornuate uteri, and those presenting a rudimentary horn; and not infrequently in normal uteri, when one tube is markedly diseased and the other more or less normal, as in cases of hydrosalpinx and inflammatory lesions of one tube associated with occlusion of its fimbriated extremity. In such cases, when the corpus luteum is found on the side of the diseased tube, it is inferred that the ovum gained access to the uterus through the normal or only slightly diseased tube of the opposite side. Moreover, the same event has not infrequently been observed in extrauterine pregnancy.

External migration of the ovum has been produced experimentally in animals by Leopold, who excised one ovary and the opposite tube, and found in a number of such cases that the animals became pregnant after the operation. A very convincing case has been reported by Kelly, who removed the diseased left ovary and right tube from a patient, leaving the normal right ovary and left tube behind. Fifteen months later the woman was delivered at term, and seventeen months after delivery the remaining tube was removed for a ruptured extrauterine pregnancy.

I have examined specimens from numerous cases of extrauterine pregnancy, which apparently offered incontrovertible evidence of external migration of the ovum, the corpus luteum being found in the ovary of one side and the pregnancy in the opposite tube. The same condition was beautifully exemplified in a specimen which Dr. H. C. Coe sent me for examination. In this case the right tube had twice been the seat of extrauterine pregnancy. The first pregnancy, which dated from several years before, was situated in the isthmus portion of the tube, the foetus having become converted into a lithopædion which completely blocked the lumen. External to this, and occupying the lateral portion of the tube, was a freshly ruptured four months' pregnancy. The right ovary was small, atrophic, and covered by adhesions, while the left contained the corpus luteum of pregnancy. It was apparent in this case that the ovum must have been fertilized, soon after leaving the left ovary, by a spermatozoon which had made its way up the left tube; after which it had been carried to the right tube and had passed down it until arrested by the lithopædion, when it underwent further development.

Satisfactory evidence has not yet been adduced in favor of the occurrence of *internal migration* of the ovum, and it is hardly possible that such proof can ever be brought in the future, though its theoretical possibility cannot be denied. Schaeffer and Veit have conclusively demonstrated that the specimens which were formerly relied upon to establish its occurrence are open to other and simpler explanations.

**Place of Meeting of the Ovum and Spermatozoa.**—During coitus the semen is deposited in the vagina, and the question arises, How do the spermatozoa contained in it make their way into the uterus, and when and where do they come in contact with the ovum?

The number of spermatozoa contained in a single ejaculation is marvelous, and has been estimated by Lode at 226,257,900. Various explanations of the method by which they gain access to the uterine cavity have been advanced, the most widely known being the aspiration theory of Litzmann, Wernich, and Beck, and the mucus-plug theory of Kristeller. The first-mentioned observers held that the external muscles of the uterus contract forcibly during coitus and compress the uterine cavity, into which the spermatozoa are aspirated when relaxation occurs. Kristeller believed that at the height of the orgasm the thick tenacious mucus, which is usually found in the cervix, is forced down for a short distance into the vagina, where it becomes covered with spermatozoa, after which it returns to its original position and carries them with it.

It cannot be denied that spermatozoa may gain access to the uterine cavity in either of these ways in a certain number of cases; but in the majority of instances it is probable that they may make their way thither by their own activity. Moreover, the observations of Löw indicate that the mucous secretion of the uterus possesses a positive attraction for them, as can be verified under the microscope. That this view is correct is demonstrated by the instances of pregnancy following imperfect coitus, and particularly those which have been observed in women with unruptured hymens. Furthermore, it has been shown by Henle that spermatozoa can move at quite a rapid rate, being able to travel a distance of 1 centimeter in three minutes.

It was formerly taught that *impregnation* normally occurred in the uterine cavity, and it was believed by Tait, Wyder, and other observers that conjugation was favored by the direction of the currents produced by the cilia of the uterus and the tubes, the former being directed from below upward, and the latter from above downward, so that the two met in the upper part of the uterine cavity. Thus, the ciliary current would favor the entrance of spermatozoa into the uterus, while rendering impossible their entry into the tubes, except in diseased conditions. But in view of the observations of Hofmeier, Mandl, and others, which show that the ciliary current is directed from above downward, in the uterus as well as in the tubes, it is apparent that this theory must be abandoned, and it must be admitted that the spermatozoa have to make headway against the current from the time they enter the internal os.

It is probable that spermatozoa can nearly always be found in the tubes of married women, into which they make their way by their own motility. Living spermatozoa have been observed in the tubes of women by Birch-Hirschfeld and Dührssen, and it is a well-known fact that they retain their activity in the tubes of the bat for many months. Years ago Bischoff showed that they could be found on the surface of the ovaries of animals for a certain length of time after copulation, and the occurrence of ovarian pregnancy demonstrates that the same may occur in women.

From the evidence available, it appears to be tolerably satisfactorily demonstrated that in women who copulate at frequent intervals the tube must be regarded as a species of *receptaculum seminis*, in which spermato-



zoa are always present and waiting for the ovum, and that fertilization usually occurs in the tubes and only rarely in the uterus.

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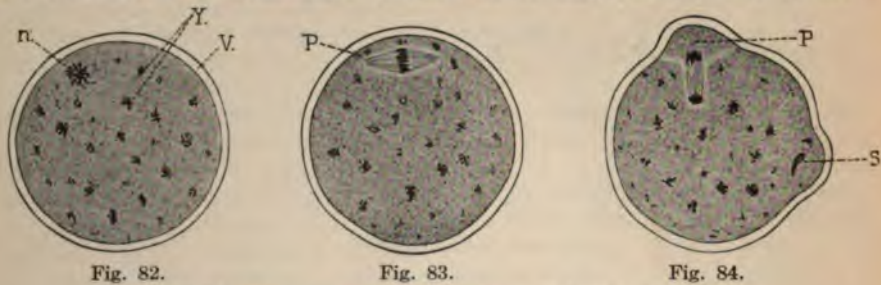
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## CHAPTER IV

### MATURATION, FERTILIZATION AND DEVELOPMENT OF THE OVUM

In the present work we shall not attempt to trace the development of the ovum through all its stages, but shall consider only those changes which are directly concerned in the formation of the foetal membranes and the placenta. For detailed information concerning the general development of the embryo the student is referred to the standard works upon embryology.

**Maturation of Ovum.**—The ovum, as it occurs in the mature Graafian follicle, is not adapted for fertilization and further development until it has undergone certain changes, more especially noticeable in its nucleus, which may be regarded as signs of maturation. This consists in the formation and extrusion of the polar bodies, which leads to the reduction in the number of chromosomes to one half of that characteristic of the



FIGS. 82-84.—FORMATION OF POLAR BODY (Sobotta).  $\times 500$ .  
 n., nucleus; V., vitelline membrane; Y., yolk granules; P., polar spindle; S., head of spermatozoon.

somatic cells. The process has not as yet been proved for human beings; but, as it has been observed in all the lower animals which have been studied, it is reasonable to suppose that it also occurs in man. The changes are supposed to begin just before the rupture of the follicle, and to be completed while the ovum is in the upper portion of the tube, though occasionally they may take place while it is still within the ovary. The process is most readily understood by the study of ova having but few large chromosomes. Accordingly, the egg of the *ascaris megalocephala*, which possesses four chromosomes, is usually chosen for its demonstration.

Sobotta made an exhaustive study of the process in the mouse, and it is from his article that most of our statements are taken. When the process



of maturation is about to begin, the germinal vesicle approaches the surface of the ovum, or oocyte of the first order, and appears to become smaller, while at the same time its membrane disappears. It gradually becomes less and less distinct, until finally its situation is indicated by a clear area surrounded by deutoplasm, which is traversed by many radiating lines. In a short time this area becomes transformed into a typical caryocinetic or mitotic figure, which undergoes the usual changes and soon becomes spindle-shaped. The spindle, when it first appears, is situated tangentially to the surface of the ovum, but later turns and becomes perpendicular to it. The chromatin of the spindle then becomes rearranged and a typical dyaster is formed (Figs. 82 to 84). Division rapidly ensues, and the new nucleus nearest the surface, with the portion of protoplasm surrounding it, is cut off from the rest of the ovum and comes to lie between it and the vitelline membrane. In this way is formed the oocyte of the second order and the

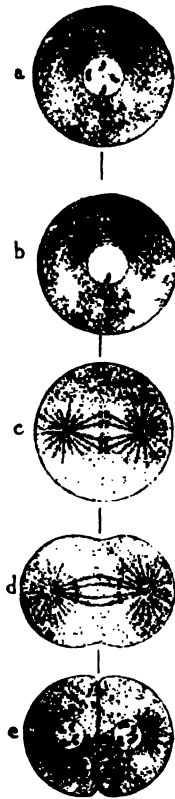


FIG. 85.—DIAGRAM SHOWING NORMAL CELL DIVISION WITH FOUR CHROMOSOMES. *a*, cell with four chromosomes; *b*, formation of spindle; *c*, splitting of chromosomes in spindle; *d*, separation of daughter chromosomes; *e*, complete separation into two cells each with four chromosomes.

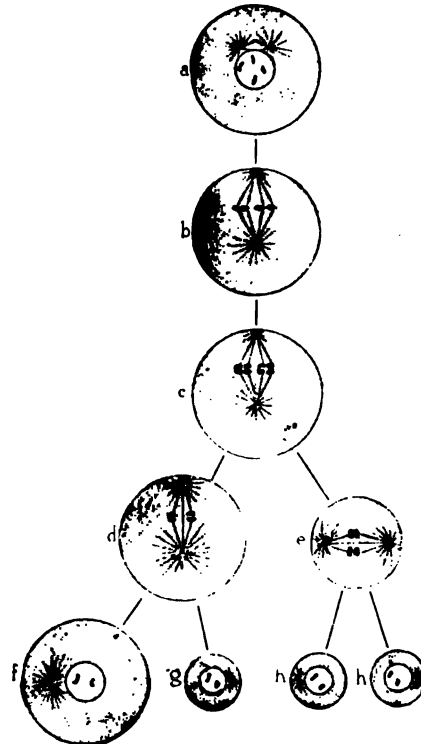


FIG. 86 —DIAGRAM SHOWING THE REDUCTION IN THE NUMBER OF CHROMOSOMES IN THE MATURATION OF THE OVUM. *a-b-c*, oocyte of first order in various stages of division; *d*, oocyte of second order; *e*, first polar body; *f*, mature ovum; *g*, second polar body; *h*, cells derived from division of first polar body.

first *polar body*. As the process is a typical cell division, the nucleus of both the oocyte and the polar body will contain the typical number of chromosomes.

Almost immediately a new spindle appears in the oocyte, and division occurs without preliminary cleavage of the chromosomes, so that two cells are formed, each of which has only one half the number of chromosomes characteristic of the species. One of these is cast off as the second polar body, while the remaining large cell is the mature ovum, whose nucleus is then designated as the female pronucleus.

As the first polar body is formed by typical cell division, it must be regarded as homologous with the oocyte, from which it differs only by its smaller size; and it may divide again, giving rise to two cells. On the other hand, the second polar body is homologous with the mature ovum, and contains only one half the number of chromosomes characteristic of the body cells. Under abnormal conditions it may likewise become fertilized; in which event, according to the theories of Bonnet, Wilms, and Marchand, it may play a part in the production of teratomata. It would therefore appear that in the process of maturation six cells may develop from the original oocyte of the first order: by the non-reducing division, the oocyte of the second order and the first polar body; while by the reducing division the former gives rise to the mature ovum and the second polar body, and the latter to two cells homologous with the second polar body (Fig. 86).

Maturation is essentially a means of reducing the number of chromosomes, though its exact significance is not clear. Following the theory of Weissman, it is generally believed that the object of the reduction is to make possible the introduction of the paternal chromosomes into the ovum at the time of fertilization, without increasing the number of chromosomes characteristic of the species, as must inevitably occur if some such mechanism were not provided. In any event, the process must be regarded as a necessary preliminary to normal fertilization and further development of the ovum.

As the researches of Flemming and Duesberg apparently show that the somatic cells of human beings contain twenty-four chromosomes, it must follow that they are reduced to twelve in the mature ovum and second polar body.

**Fertilization.**—By fertilization is understood the union of a spermatozoon and the mature ovum. Each *spermatozoon* consists of three portions—the head, tail, and intermediate portion. The head is somewhat triangular in shape and flattened from side to side; it contains a definite amount of chromatin, which is derived from the mother cells of the testicle (Fig. 87). Interpolated between the

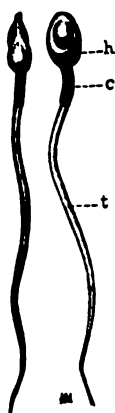


FIG. 87.—HUMAN SPERMATOOZOA.

*h*, head; *c*, intermediate portion; *t*, tail.

long tail and the head is a small cylindrical body, the intermediate portion. The spermatozoa are endowed with marked motility, derived from the rapid vibration of their tails, and, according to Henle, can traverse a distance of 1 centimeter in three minutes.

In spermatogenesis, changes are observed analogous to those occurring in the maturation of the ovum, and it has been clearly shown that each spermatocyte of the first order divides into two cells, each of which in turn gives rise to two others containing only one half the number of chromosomes characteristic of the species (Fig. 88). These latter are the spermatids, which later become the spermatozoa. Each spermatozoon, therefore, must be regarded as a distinct cell, which is analogous with the mature ovum and the second polar body.

As has already been pointed out, the spermatozoon and ovum usually come together in the lateral portion of the tube, which may be regarded as a species of receptaculum seminis, although in rare instances the meeting may take place on the surface of the ovary or even in the Graafian follicle, as is demonstrated by the occurrence of ovarian pregnancy.

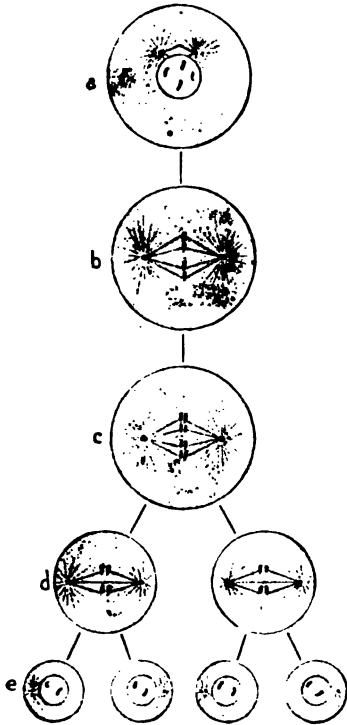


FIG. 88.—DIAGRAM SHOWING THE REDUCTION IN THE NUMBER OF CHROMOSOMES IN SPERMATOGENESIS IN A SPECIES WITH FOUR CHROMOSOMES IN THE NUCLEUS.

*a-b-c*, spermatocyte of first order in various stages of division; *d*, spermatocyte of second order; *e*, spermatids with two chromosomes each.

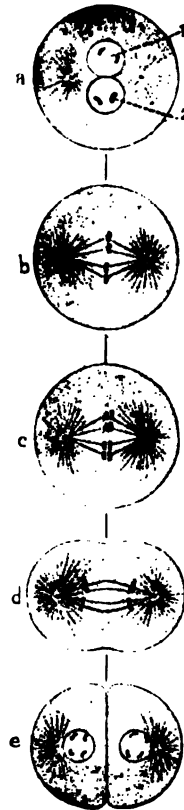


FIG. 89.—DIAGRAM SHOWING FERTILIZATION AND SEGMENTATION OF THE OVUM.

*a*, fertilization: 1, male pronucleus; 2, female pronucleus; *b-c*, formation of spindle with chromosomes derived from both ovum and spermatozoon; *d-e*, cell division showing perpetuation of paternal and maternal chromosomes in body cells.

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In the lower animals in which the process of fertilization has been studied the ovum is found in the lateral end of the tube, surrounded by a considerable number of spermatozoa, as many as 60 having been counted about a single ovum. These rapidly penetrate the vitelline membrane, but it appears that only one of them makes its way into the ovum, and that after its entry the superficial portion of the latter becomes impervious to other spermatozoa.

After the head has entered the ovum the tail rapidly disappears, and in a short time nothing is left of the original spermatozoon but a small spindle-shaped mass, the *male pronucleus* (Fig. 84). This rapidly makes its way to the center of the ovum, where it meets and fuses with the female pronucleus to form the segmentation nucleus.

As the male and female pronuclei each contain only one half the number of chromosomes characteristic of the species, their union restores the number to the normal type (Fig. 89). Thus, in ascaris, two of the chromosomes of the segmentation nucleus are of paternal and two of maternal origin, while in man twelve come from each cell. Moreover, as the chromosomes of both the mature ovum and the spermatozoon are the direct descendants of those concerned in the fertilization of the parent organisms, it is apparent that the process does not consist merely in the union of so many paternal and maternal chromosomes, but has a much broader significance, in that it brings together nuclear substances derived from the ancestors of both parents, and thus affords a basis for a comprehensible theory of heredity. In the case of man, where the mature ovum and spermatozoon each contain twelve chromosomes, it is apparent that many different combinations are possible, and Ziegler has calculated that any one of one hundred and sixty-nine possibilities may have to be reckoned with.

Ordinarily segmentation does not begin until after fertilization, but it is well known that in many of the lower animals it is not necessarily dependent upon the fusion of the male and female elements—parthenogenesis. It has been repeatedly shown in recent years that segmentation may be inaugurated without the presence of spermatozoa by subjecting the mature ovum to the action of various chemical agents, such as weak solutions of acids or alkalies—artificial parthenogenesis. In such cases development appears to progress normally up to a certain point, but at present there is no evidence available to indicate that thoroughly formed animals will result.

Lefevre, 1907, has shown in *Thallasema* that the egg under such conditions casts off two polar bodies, as usual, but that the cells resulting from segmentation possess only one half as many chromosomes as when fertilization occurs. Accordingly, it would appear that the process of fertilization may be resolved into two parts: the fusion of the male and female chromosomes, and the inauguration of segmentation. In the higher animals it would seem that the two functions are inseparable, while experiments upon artificial parthenogenesis in some of the lower species clearly show that the latter may occur absolutely independently of the former. In view of such facts, Loeb in 1909 stated that spermatozoon



may be regarded as an activator, which serves to stimulate nuclein synthesis.

For a time it was believed that the centrosome—the structure which apparently presides over the act of cell division—disappeared from the ovum during the last phases of maturation, and accordingly the mature ova could not begin to segment until the lacking structure had been restored by means of the male pronucleus. This, however, cannot be accepted as a universal rule, particularly in view of the fact that such a possibility is lacking in artificial parthenogenesis.



FIGS. 90-92.—CHANGES IN THE SEGMENTATION NUCLEUS (Sobotta).  $\times 500$

P., polar body; s.n., segmentation nucleus.

**General Development of Ovum.**—Soon after the appearance of the segmentation nucleus, caryokinetic changes take place within it and give rise to a typical nuclear spindle, which is soon converted into a dyaster, to be speedily followed by the division of the ovum into two cells (Figs. 90 to 92). Each of these in turn divides, giving rise to four cells, though Sobotta's investigations on the mouse show that one of the original cells



FIGS. 93-95.—FORMATION OF MULBERRY MASS (Sobotta).  $\times 500$

segments earlier than the other, so that we next have three cells. This process of cell division or segmentation goes on until the original ovum becomes converted into a mass of cells, which is designated as the *morula*, or *mulberry mass* (Fig. 95).

Fluid soon appears in the mulberry mass and forces the cells to the periphery, thus giving rise to a vesicular structure consisting of a single layer of cells which surround a cavity filled with fluid—the segmentation cavity. The entire structure at this time is known as the *blastodermic vesicle*, which in the rabbit and many other animals is still surrounded

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by the vitelline membrane (Fig. 96), whereas in the mouse the latter disappears before the formation of the mulberry mass (Fig. 109).

In a short time a collection of cells can be noted at one point on the inner surface of the blastodermic vesicle. This is known as the *internal cell-mass*, while the single layer of cells forming the wall of the vesicle is

frequently spoken of as the primitive chorion (Fig. 96). When viewed by transmitted light the internal cell-mass appears darker than the rest of the surface of the blastodermic vesicle, and hence is called the *macula embryonalis*. Sections made through it at this point show that it is composed of several layers of cells, those nearest the exterior being ectodermal, and those nearest the segmentation cavity entodermal.

The formation of a blastodermic vesicle has not as yet been observed in the human ovum, but, as it has been demonstrated in the ova of the various species of animals which have been available for study,

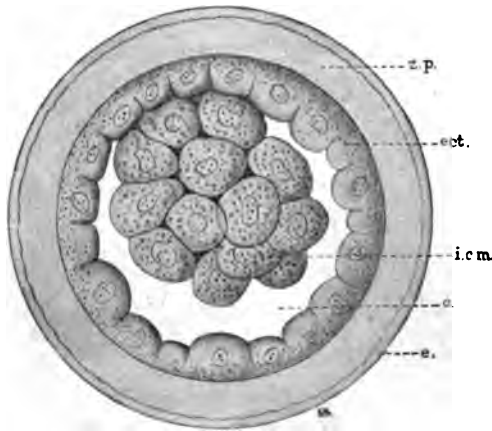


FIG. 96.—BLASTODERMIC VESICLE OF RABBIT  
(v. Beneden).

c., cavity of vesicle; ect., primitive ectoderm;  
i.c.m., internal cell-mass; z.p., zona pellucida;  
e., albuminous envelope.

there is no doubt that it occurs in all mammals. These changes are supposed to take place while the ovum is making its way through the tubes, or just after it has become implanted upon the uterine wall. The transit through the Fallopian tube is believed to occupy a period of from five to seven days, as has been verified in the guinea-pig, and appears probable in human beings; since Hyrtl upon one occasion discovered an ovum in the uterine end of the tube five days after the cessation of the menstrual period. Since the studies of Graf Spee show that in the guinea-pig the blastodermic vesicle is not formed until after the ovum has become imbedded in the decidua, it is probable that the same holds good for man. If this be the case, it could scarcely be formed before the latter part of the first week, after which it must undergo very rapid changes, as the 13 to 14-day-old human ovum described by Bryce and Teacher, which is the earliest on record, presents a much more advanced stage of development (Fig. 108).

Following the formation of the blastodermic vesicle and its internal cell-mass, the further development of the ovum varies greatly according to the intimacy of its attachment to the uterine wall. If this is loose, and there is an abundance of space in the uterine cavity, important changes promptly occur upon the surface of the vesicle, as in the rabbit and dog. On the other hand, if the ovum is very minute, and soon burrows into the depths of the uterine mucosa, these changes are lacking, so that further



development takes place in the interior of the vesicle—the so-called “inversion” of the germ layers, to which attention was particularly directed by Selenka in 1884. At first this was considered peculiar to certain rodents, but it is now known to occur in many other mammals, such as the pig, sheep, monkey, and in all probability man. We shall accordingly briefly consider the changes occurring in the rabbit and dog, and then take up in more detail those observed in certain rodents, bats, monkeys, and man.

As the cells composing the internal cell-mass proliferate, they give rise to a round or oval area at one point on the surface of the blastodermic vesicle—the *embryonic area*—which at first consists of two layers of cells representing the ectoderm and entoderm respectively. Specimens presenting this stage of development are readily obtained from rabbits and dogs.

In them the embryonic area, when viewed by transmitted light, is first round, but later oval in shape, and presents a dark center and a light periphery, which are designated respectively as the *area opaca* and the *area pellucida* (Fig. 97). This differentiation is due to the fact that the cells composing the former are arranged in several layers, whereas in the latter only two can be made out.

The embryonic area soon becomes slightly elevated above the general surface of the blastodermic vesicle, and now forms what is known as the *embryonic shield*. A

few hours later a darker zone appears at one end of the shield and soon exceeds it in size (Fig. 97, *M.S.*). This is the *mesodermic area*, which on section is seen to be made up of spindle-shaped and triangular cells. Fig. 99, representing a section through the embryonic area of a dog at this stage, shows distinctly that it is made up of two layers—ectoderm and entoderm. The mesodermic area rapidly increases in size, and soon forms a complete layer inside the blastodermic vesicle between the ectoderm and entoderm.

A little later there appears in the middle of the embryonic area a slight depression—the *primitive streak*—which is bounded on either side by a slight elevation—the *primitive folds* (Fig. 97, *P.S.*). Shortly afterward a second depression—the *medullary groove*—appears in front of

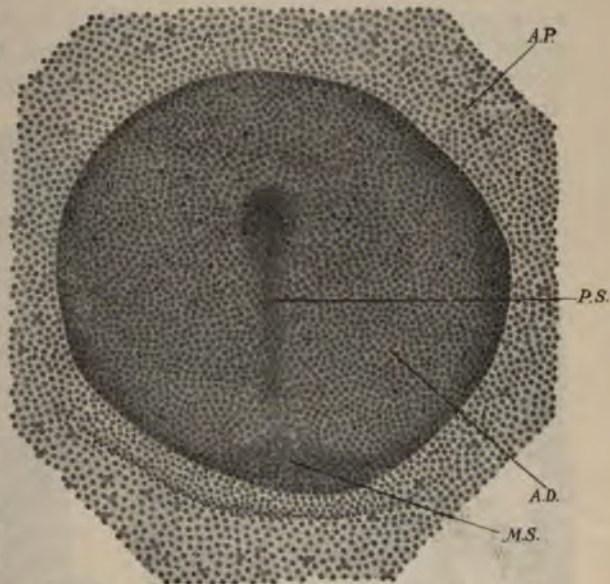


FIG. 97.—EMBRYONIC AREA, DOG (Bonnet).  $\times 90$ .

A.C., area opaca; A.P., area pellucida; M.S., mesodermic shield; P.S., primitive streak.

the primitive streak. It is bounded on either side by an elevated fold—the medullary ridges—which converge anteriorly to form the head-folds. The medullary groove is in the same line with the primitive streak, but



FIG. 98.—SECTION THROUGH EARLY EMBRYONIC AREA OF DOG (Bonnet).  $\times 180$ .

*Ec.*, ectoderm; *Ent.*, entoderm.

never unites with it; while the medullary folds diverge posteriorly and inclose the anterior end of the primitive streak (Fig. 99). As the ovum becomes older the medullary groove and folds, which result from proliferation of the ectoderm and later give rise to the central nervous system, rapidly increase in size; while the primitive streak remains stationary, so that in a short time it occupies only a small portion of the embryonic area.



FIG. 99.—EMBRYONIC SHIELD OF RABBIT, SHOWING PRIMITIVE STREAK AND MEDULLARY FOLDS (Kollmann).  $\times 28$ .

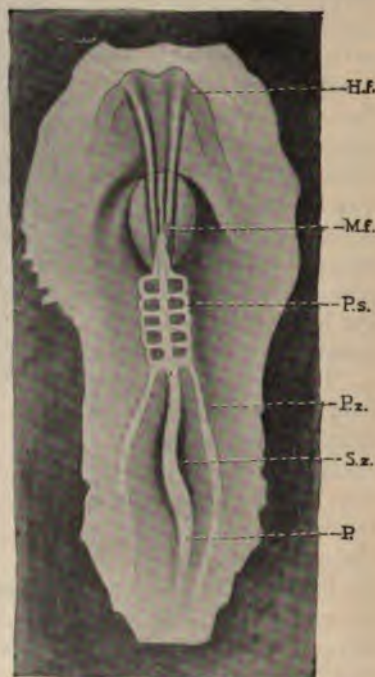


FIG. 100.—CHICKEN EMBRYO WITH FIVE SEGMENTS (Kollmann).

*H.f.*, head-fold; *M.f.*, medullary folds; *P.*, primitive streak; *P.s.*, primitive segments; *P.z.*, parietal zone; *S.z.*, segmental zone.

While these changes are taking place on the surface of the embryonic area, others of no less importance are going on in its depths, which result in the formation of the mesodermic structures. On either side of the



medullary canal can be observed a slight thickening—the segmental layer (the Stammzone of the Germans)—outside of which is a thinner layer—the parietal zone (Fig. 100). The segmental layer soon becomes divided



FIG. 101.—SECTION THROUGH AREA OF DOG SHOWING THREE LAYERS (Bonnet).  $\times 180$ .  
Ect., ectoderm; Ent., entoderm; M., mesoderm; M.G., medullary groove.

up into a number of more or less cuboidal masses of tissue on either side of the medullary groove, which are variously designated as *protovertebræ*, primary segments, or mesoblastic somites; from these the musculature of



FIG. 102.—SECTION THROUGH DOG EMBRYO SHOWING GREATER DEVELOPMENT OF MESODERM (Bonnet).  $\times 180$ .

Ect., ectoderm; Ent., entoderm; M., mesoderm; M.G., medullary groove.

the dorsal portion of the body is developed. The parietal zone, which is also made up of mesoderm, soon becomes divided into two layers which inclose a cavity, the *coelome*. The outer layer is covered by ectoderm, and is designated as the *somatopleure*, while the inner is lined by entoderm



FIG. 103.—SECTION THROUGH DOG EMBRYO SHOWING FORMATION OF AMNION (Bonnet).  $\times 100$ .

C., coelome; Ch., notochord; Ect., ectoderm; Ent., entoderm; M., mesoderm; Som., somatopleure; Spl., splanchnopleure.

and is called the *splanchnopleure*. From a part of the former the anterior and lateral abdominal walls are developed, while in many animals its greater portion gives rise to the chorion and amnion.

Thus far we have considered the growing ovum as seen from without;

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but the study of microscopical sections through it aids us still further in understanding its development. Fig. 98 represents a section through the embryonic area at an early period, and shows that the greater part of the blastodermic vesicle is composed of two layers of cells, the *ecto-*

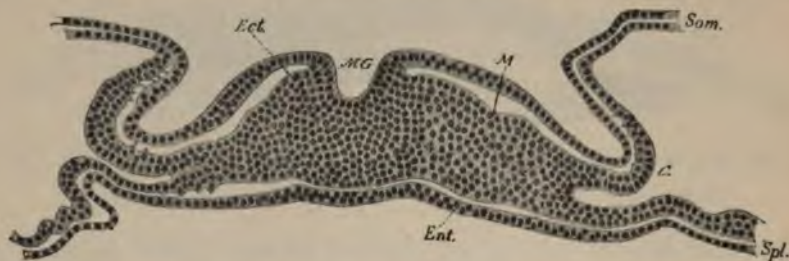


FIG. 104.—SECTION THROUGH DOG EMBRYO SHOWING FORMATION OF AMNION, WITH GREATER DEVELOPMENT OF SOMATOPLEURE (Bonnet).  $\times 100$ .

*C.*, coelome; *Ch.*, notochord; *Ect.*, ectoderm; *Ent.*, entoderm; *M.*, mesoderm; *Som.*, somatopleure; *Spl.*, splanchnopleure.

*derm* and the *entoderm*, while in the region of the embryonic area the former is arranged in several layers, whereas the latter consists of a single layer. Fig. 101 represents a section through the embryonic area of a dog at a little later stage, and shows three distinct layers—ectoderm, meso-

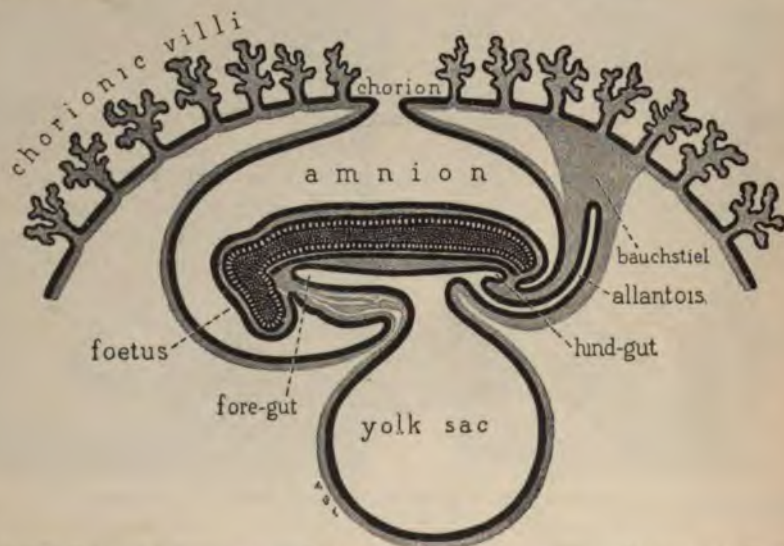


FIG. 105.—DIAGRAM REPRESENTING LONGITUDINAL SECTION THROUGH MAMMALIAN EMBRYO, SHOWING FORMATION OF AMNION.

derm, and entoderm. In Fig. 102 a still later period of development is shown; the medullary groove is well marked, and the mesoderm has become thickened to form the segmental layer.

From the ectoderm are developed the central nervous system and the



cutaneous structures; from the mesoderm are derived the muscular and circulatory portions of the body, the reproductive organs and the connective-tissue framework of the various other organs; while the entoderm gives rise to the digestive tract and the organs which are more or less intimately connected with it.

In the chicken, rabbit, dog, and many other mammals the *chorion* and *amnion* are not formed until the parietal layer of the mesoderm has become well developed and, together with the ectoderm and entoderm, has been differentiated into the somatopleure and splanchnopleure (Figs. 103 and 104). Then folds of somatopleure arise at the head and tail ends and sides of the embryo and, gradually arching over it, meet together and fuse, thus inclosing its dorsal surface by two membranes. The outer of these, the *chorion*, is composed of an outer layer of ectoderm and an inner layer of mesoderm; while in the inner membrane, or *amnion*, the mesoderm is without and the ectoderm within, toward the embryo (Fig. 105).

**Implantation of Human Ovum.**—According to Grosser, the segmenting human ovum does not exceed 0.2 mm. in diameter when it reaches the uterine cavity, and does not become implanted until at least nine days after the fruitful coitus. Moreover, it has already been stated that it is probably still in the morula stage and has not developed into a blastodermic vesicle. These, however, are mere suppositions, as no one has as yet observed a human ovum in the process of implantation; consequently, we are forced by analogy to believe that the process is effected in the same manner as in the guinea-pig.



FIG. 106.—GUINEA PIG'S OVUM ATTACHED TO UTERINE MUCOSA, SEVENTH DAY (Spee).  $\times 375$ .

C., segmentation cavity; Ep., uterine epithelium; O., ovum; Z., zona of pellucida.



FIG. 107.—OVUM OF GUINEA PIG BURROWING THROUGH UTERINE MUCOSA, SEVENTH DAY (Spee).  $\times 375$ .

C., capillary; D., decidua; Ep., uterine epithelium; O., ovum.

Graf Spee has demonstrated that the ovum of that animal reaches the uterus during the seventh day after fertilization while still in the morula stage, when, owing to the viscosity of its exterior, it becomes attached to the free surface of the endometrium. As the result of a supposed digestive action, the epithelium immediately beneath it is destroyed, and the stroma liquefied, so that a cavity is formed into which the ovum sinks and gradually descends into the depths of the decidua. Following this, the margins of the opening coalesce, so that the ovum eventually comes to lie in a cav-

ity which has no communication with the interior of the uterus. (Figs. 106 and 107.)

Such a procedure does not imply so radical a destruction of tissue as one might at first suppose, as Spee states that it involves only an area the width of four or five epithelial cells. Moreover, the digestive action is not entirely theoretical, as Gräfenburg has demonstrated that foetal epithelial cells contain a tryptic ferment which in laboratory experiments is capable of digesting tissues.

As early as 1896, Herff stated that it was probable that the human ovum became implanted by a similar mechanism, but it was not until

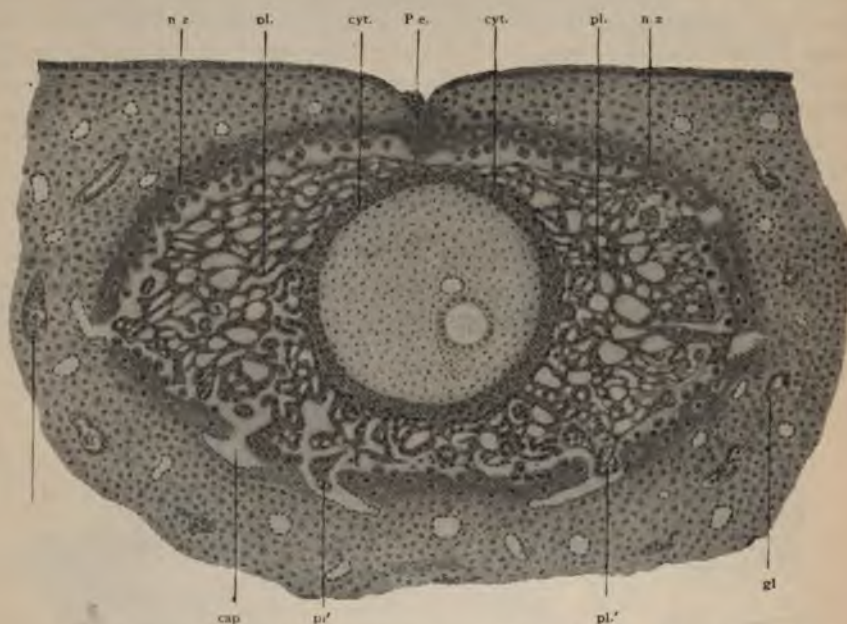


FIG. 108.—DIAGRAM OF TEACHER-BRYCE OVUM.  $\times 50$ . (T. H. Bryce, Del.)

*P.e.*, point of entrance; *cyt.*, cyto-trophoblast; *pl.*, plasmodi-trophoblast; *n.z.*, necrotic zone of decidua; *gl.*, gland; *cap.*, capillary; *pl.*, masses of vacuolating plasmodium invading capillaries. The cavity of the blastocyst is completely filled with mesoblast, and imbedded therein are the amnio-embryonic and entodermic vesicles. The natural proportions of the several parts have been strictly observed.

1899, following the description by Peters of a very early ovum in situ, that such views were seriously considered. This ovum (Plate V) measured  $1.6 \times 0.9 \times 0.8$  mm., and, as it was entirely embedded in the decidua, surrounded by many layers of ectodermal cells and completely separated from the uterine cavity, Peters concluded that such a condition could be explained only by some such mechanism as that described by Spee; at the same time he demonstrated the incorrectness of the then prevailing views upon the subject.

Up to 1911 at least ten early ova in situ have been described, none exceeding 5 mm. in diameter, and varying in age from the end of the



second to the end of the third week. They were described by the following authors, and are arranged according to their age:

Bryce and Teacher, Peters, Heine and Hofbauer, Leopold, Herzog, Jung, Spee, Merttens, Beneke and Fetzner.

In each instance the ovum lay in the depths of the decidua and was separated from the uterine cavity by a definite layer of tissue. Fig. 108 is a diagram of the ovum described by Bryce and Teacher, and gives a good idea of the conditions. This, the youngest human ovum yet recorded, measured 0.77 x 0.63 mm. and is probably 13 days old; while the depression marked *P. c.* probably represents its point of entrance into the decidua.



FIG. 109. — OVUM OF MOUSE. SECOND HALF OF FOURTH DAY (Sobotta). X 450.

*S.C.*, segmentation cavity.



FIG. 110. — BLASTODERMIC VESICLE OF MOUSE. END OF FOURTH DAY (Sobotta). X 450.

*S.C.*, segmentation cavity.

**Development of Chorion and Amnion.**—In many mammals further development does not take place upon the surface of the blastodermic vesicle, as has just been described, but rather in the interior of the internal cell-mass. This process was first described by Selenka and Spee in certain rodents, and was believed to represent an actual inversion of the germ layers. Later investigation, however, has shown that it is a much more widely spread process, and occurs in many species of animals.



FIG. 111. — BLASTODERMIC VESICLE OF MOUSE. FIFTH DAY (Sobotta). X 450.  
*S.C.*, segmentation cavity.

It would appear that the term does not correctly describe the process in all instances, as inversion does not occur in the strict sense of the word, but is simulated by the development of the embryonic area at a point more or less removed from the external surface of the blastodermic vesicle. Sobotta, in 1903, published an excellent description of the process in the mouse, from which many of the statements concerning its early stages are taken.

After fertilization, the segmented ovum can be found in the uterine cavity as a morula mass, and Figs. 109 and 110 show it being transformed into a blastodermic vesicle; while Fig. 111 shows a later stage, with a well-developed cavity and an internal cell-mass. The latter proliferates rapidly, and a little later the layer of cells on its inner surface becomes differentiated from its neighbors and stains more intensely. This is the first appearance of the entoderm, while all the other cells are to be regarded as ectodermal (Figs. 112 and 113).

The internal cell-mass then proliferates rapidly, and soon gives rise to a more or less cylindrical structure, composed of closely packed cells,

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which projects into the cavity of the vesicle. This is covered by a single layer of cuboidal entodermal cells, while the ectodermal cells which form the wall of the vesicle lose their cuboidal appearance and become almost flattened (Fig. 114). Gradually the entodermal cells ex-



FIG. 112. — BLASTODERMIC VESICLE OF MOUSE. FIRST HALF SIXTH DAY (Sobotta).  $\times 300$ .

*Ect.*, ectoderm; *Ent.*, entoderm.

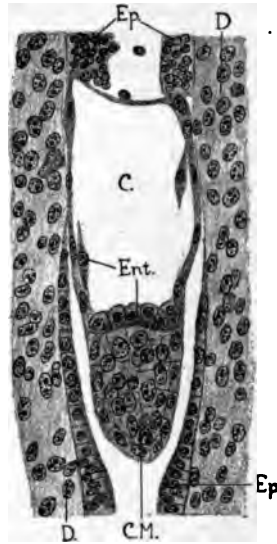


FIG. 113. — BLASTODERMIC VESICLE OF MOUSE IN UTERINE CAVITY, SECOND HALF OF SIXTH DAY (Sobotta).  $\times 300$ .

*C.*, cavity of ovum; *C.M.*, cell-mass; *Ent.*, entoderm; *Ep.*, uterine epithelium; *D.*, decidua.

tend outward beyond the cylindrical structure, and eventually come to line the entire interior of the blastodermic vesicle, where they form the epithelial lining of the yolk-sac.

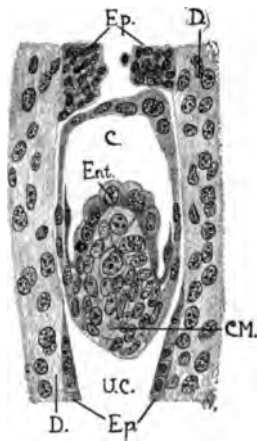


FIG. 114. — BLASTODERMIC VESICLE OF MOUSE IN UTERINE CAVITY, SECOND HALF OF SIXTH DAY (Sobotta).  $\times 300$ .

*U.C.*, uterine cavity; *C.*, cavity of ovum; *C.M.*, cell mass; *Ent.*, entoderm; *Ep.*, uterine epithelium; *D.*, decidua.

While these changes are taking place, the ovum becomes firmly attached to the uterus, and, after the disappearance of its epithelium, comes into direct contact with the connective tissue of the mucosa (Figs. 115 and 117). At the same time, the cells at the outer portion of the cell-mass multiply rapidly, and give rise to the ectoplacenta, which, invading the adjacent maternal tissue, opens up its blood-vessels, thus bringing the foetal cells and the maternal blood into direct contact. Almost simultaneously, a longitudinal split appears in the underlying cylindrical mass of cells. This rapidly becomes larger and gives rise to a cavity lined by

a single layer of ectodermal cells—the amniotic cavity (Fig. 117).

Thus far no trace of the future embryo is apparent, but soon the cells at one point upon the wall of the primitive amnion begin to proliferate, and give rise to a typical embryonic area, which then undergoes the same



FIG. 115. — BLASTODERMIC VESICLE OF MOUSE IN UTERINE CAVITY, SEVENTH DAY (Sobotta).  $\times 300$ .

*Am.*, amniotic cavity; *Ep.*, uterine epithelium; *C.M.*, cell-mass; *D.*, decidua; *U.C.*, uterine cavity; *Ent.*, entoderm; *C.*, cavity of ovum.



FIG. 116. — BLASTODERMIC VESICLE OF MOUSE IN UTERINE CAVITY, FIRST HALF OF SEVENTH DAY (Sobotta).  $\times 300$ .

*Ep.*, uterine epithelium; *C.*, cavity of ovum; *Ent.*, entoderm; *D.*, decidua; *C.M.*, cell-mass.

cycle of changes as in the rabbit, except that the somatopleure takes no part in the formation of the amnion. With the development of the mesoderm the entoderm becomes separated from the ectoderm, with the resulting formation of the yolk-sac, the allantois, and the extra embryonic coelome.

The researches of Graf Spee have demonstrated the occurrence of practically identical changes in the guinea-pig, except in the fact that the ovum becomes embedded in the depths of the uterine mucosa before the development of the blastodermic vesicle.

Van Beneden has shown that the development of the amnion and embryo occurs in a somewhat similar manner in the bat. In this case, however, the internal cell-mass does not give rise to a cylindrical projection into the cavity of the blastodermic vesicle, but forms a lenticular enlargement upon its inner surface. By the degeneration of the cells in its center a cavity appears, which is that of the amnion, while the embryo is developed from the cells at its base (Figs. 118, 119 and 120).



In monkeys the earliest stages of development have not been observed, but the early ova described by Selenka leave no doubt as to the mode of origin of the amnion and embryo. Thus, Fig. 122, which represents a section through an early ovum of the gibbon, shows a well-developed chorion and coelomic cavity, while the small amnion and embryonic area hang by a pedicle from the inner surface of the chorion. At the point marked "I" in the drawing is a depression upon the outer surface of the chorion,

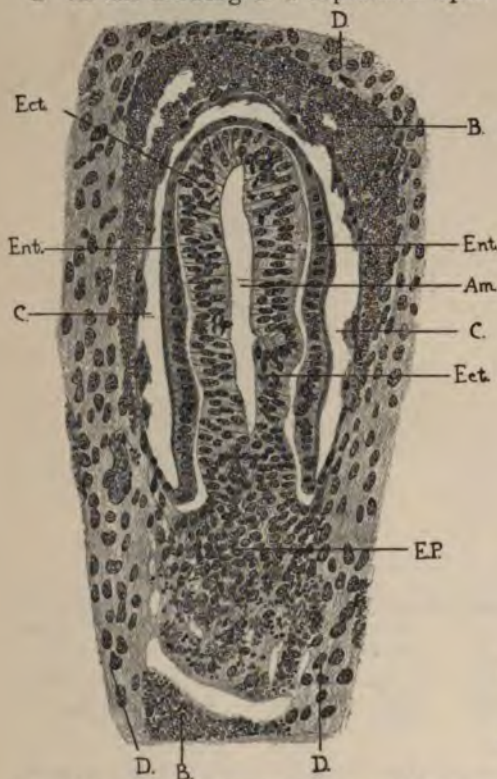


FIG. 117.—BLASTODERMIC VESICLE OF MOUSE IN UTERINE CAVITY, EIGHTH DAY (Sobotta).  $\times 225$ .

Am., amniotic cavity; B., blood; C., cavity of ovum; D., decidua; Ect., ectoderm; Ent., entoderm; E.P., ecto-placenta.

which in all probability represents the point of inversion. Likewise, Fig. 120, showing a section through a semnopithecus ovum, presents a typical early placenta with well-developed chorionic villi. There is a large coelomic cavity, while a very small amnion is loosely attached to the interior of the chorionic membrane. The embryo is represented by a minute embryonic area and a yolk-sac, and it is evident that the former must have originated at some point on the inner surface of the amnion.

The earliest human ovum with which we are acquainted was described by Bryce and

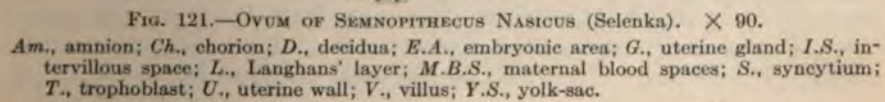
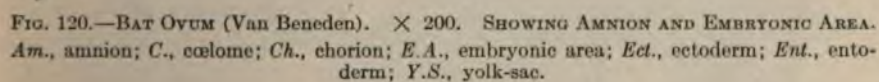
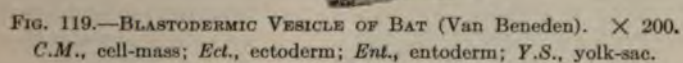


FIG. 118.—BLASTODERMIC VESICLE OF BAT (Van Beneden).  $\times 275$ .

C., cavity of vesicle; C.M., internal cell-mass; E., enveloping layer.

Teacher in 1908, and, although we are entirely ignorant concerning its earlier stages, there is every reason to suppose that it became implanted upon the uterine mucosa, as already described. This specimen, which was found in a shred of decidual tissue expelled eleven days after the menstrual period should have begun, measured  $0.77 \times 0.63$  millimeter, and was probably 13 or 14 days old (Fig. 108). It consisted of a blastodermic vesicle filled by mesodermic tissue, which contained two small cavities: the larger, lined by a single layer of cuboidal cells, representing the amnion, and the smaller, lined by flattened cells, representing the yolk-





sac. Immediately surrounding the vesicle, and representing the early chorion, were several layers of ectodermal cells, presenting all stages of cell division, while springing from their periphery were irregularly shaped branching and interlacing masses of vacuolated protoplasm, not divided into individual cells, which extended to the margin of the implantation cavity and opened up maternal blood-vessels, whose contents then escaped

into the spaces of the protoplasmic network. This entire tissue is designated as the trophoblast, the individual cells probably corresponding to the Langhans cells of the chorion, and the protoplasmic masses to the syncytium.

The next earliest human ovum was described by Peters in 1899, and is of special interest for the reason that its description formed the basis for our present ideas concerning the embedding of the ovum and the development of the chorion and amnion in man. This specimen, which Peters considered to be only three or four days old, is actually older than the one just described, and was found in the uterus of a woman who committed suicide three days after missing her menstrual period. It measured  $1.6 \times 0.8 \times 0.9$  millimeter in its various diameters, and presented a well-developed chorion and a very small amnion. Plate IV represents a section through the portion of decidua in which it was embedded, and shows that the chorion is made up of two layers—a thin inner layer of connective tissue which is poor in cells and forms the lining of the coelomic cavity, and an



FIG. 122.—SECTION THROUGH YOUNG OVUM OF HYLOBATES, SHOWING FORMATION OF AMNION (Selenka).  $\times 8$ .

A., amnion; a., amniotic pedicle; B., blood-vessel; C., chorion; C.V., chorionic villi; D., decidua; E., embryo; I., point of inversion of blastodermic vesicle; Int., intervillous space; Y.S., yolk-sac.

outer layer composed of many layers of epithelial cells. The latter form a capsule of varying thickness about the periphery of the ovum—the *trophoblast*—which in Peters's opinion represents the primitive ectoderm of the ovum. The majority of the cells possess well-marked roundish or cuboidal



bodies and vesicular nuclei. Scattered between them are masses of protoplasm which show no sign of division into individual cells, and contain irregularly shaped, darkly stained nuclei. The trophoblast has invaded the surrounding decidual tissue and opened up numerous blood-vessels, so that many comparatively large blood spaces have been formed in it. From the underlying connective tissue of the chorion numerous small processes project into the trophoblast and represent the earliest stages in the formation of chorionic villi.

Accordingly, in these two specimens we find a well-developed foetal ectoderm, the chorion, and a very rudimentary amnion. In Bryce and Teacher's specimen the latter was a minute cavity lined by a single layer of undifferentiated cells, while in Peters's ovum, as shown in Fig. 123,



FIG. 123.—PORTION OF PETERS'S OVUM, HIGHLY MAGNIFIED, SHOWING EARLY STAGE IN DEVELOPMENT OF EMBRYO.

A., amnion; C., chorion; ect., ectoderm; ent., entoderm; mes., mesoderm; E.S., embryonic shield; Y.S., yolk-sac; Sp., portion of coelom.

the small flattened amnion was in contact with the chorion, with the cells upon one side of it differentiated to form a rudimentary embryonic area. As practically identical conditions were found in the ovum of Heine and Hofbauer, it would appear that these structures could not have developed upon the outer surface of the blastodermic vesicle, and consequently we must conclude that the amnion could not be derived from folds of somatopleure, which are not formed until the embryo has attained quite an advanced stage of development. Furthermore, it seems justifiable to assume that in human beings the chorion represents the outer wall of the blastodermic vesicle, and that the amnion is developed by a process of "inversion"; while the embryo is derived from an embryonic area which appears at some point upon the inner surface of the latter.

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An ovum from the third week, described by Graf Spee, gives us important information concerning the amnion, and, although it does



FIG. 124.—MICROSCOPIC SECTION, SHOWING OVUM EMBEDDED IN DECIDUA AND SURROUNDED BY DECIDUA REFLEXA PROBABLY 17 DAYS OLD (Leopold).

not present the earliest stages in its formation, it serves to confirm the

views just stated. The entire ovum in this case measured 6 x 4.5 millimeters in diameter, and possessed a well-developed chorion, a portion of which is shown in Fig. 125. Projecting from its interior is a small vesicular structure—the beginning embryo.



FIG. 125.—SPEE'S HUMAN OVUM, EMBRYONIC AREA, 0.4 MILLIMETER LONG. X 24.

A., amnion; Bs., abdominal pedicle; C., chorion; c.e., chorionic epithelium; c.m., chorionic mesoderm; V., chorionic villi; Y., yolk-sac.

Fig. 126 represents a section through the same ovum, and shows clearly the relations of its various parts. The embryo is attached to the inner surface of the chorionic membrane by a mesodermic pedi-



cle, which represents the earliest stage of the *abdominal pedicle* (the *Bauchstiel* of the Germans), which is the precursor of the umbilical cord. The greater portion of the embryo is occupied by the yolk-sac, from one end of which a small process, lined by entoderm, which must be considered as a rudimentary allantois, extends into the pedicle. Occupying one side of the pedicle is a small cavity lined by a single layer of epithelium, which represents the amnion. On one side of this, again, is a mass of cells arranged in several layers—the embryonic area, in which a primitive streak can be distinguished. Fig. 127 represents a highly magnified section through the same ovum, and shows that the three germ layers are well developed and, with the exception of the entoderm, consist of several layers of cells.



FIG. 126.—SECTION THROUGH SPEE'S OVUM, SHOWN IN PRECEDING FIGURE.  $\times 24$ .

c., chorionic membrane; ect., ectoderm; mes., mesoderm; am., amnion; e., beginning embryo; bs., abdominal pedicle; all., allantois; y.s., yolk-sac.



FIG. 127.—CROSS-SECTION THROUGH SPEE'S OVUM. HIGHLY MAGNIFIED.

E.A., embryonic area; P., primitive streak; ect., ectoderm; ent., entoderm; mes., mesoderm.

Fig. 128 and 129 represent an older ovum, with an embryonic area 2 millimeters long, which was also described by Graf Spee, and which he believed belonged to the third week of pregnancy. The embryo is attached to the inner surface of the chorion by the abdominal pedicle, and is made up in great part of the yolk-sac. The embryonic area is oval in shape, and presents a definite medullary

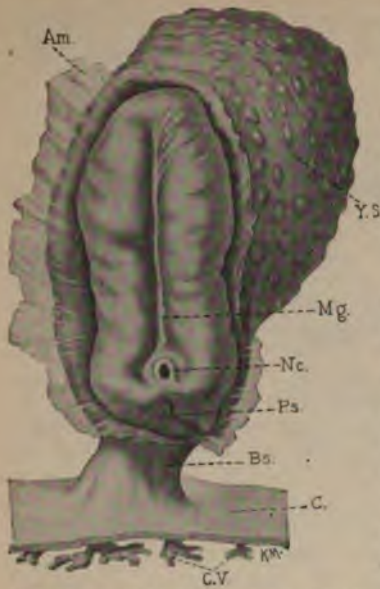


FIG. 128.—HUMAN EMBRYO 2 MILLIMETERS LONG (Graf Spee).  $\times 30$ . Am., amnion; C., chorion; C.V., chorioic villi; Bs., Bauchstiel; M.g., medullary groove; N.c., neurenteric canal; P.s., primitive streak; Y.s., yolk-sac.

**Structure of the Chorion.**—In its very earliest stages the chorion probably consists of the single layer of ectodermal cells forming the wall of the blastodermic vesicle, which soon becomes lined by a mesodermic layer. Soon after the implantation of the ovum in the uterus, however, as shown by the researches of Hübner, Hückelom, Peters and Bryce and Teacher, the chorionic epithelium rapidly proliferates and forms the many-layered trophoblast. In its earliest stages the chorion is

groove and primitive streak. The two are not in the same plane, but the latter is bent almost at right angles to the former and occupies the inferior end of the embryonic area. Between the two is a small opening, the neurenteric canal, which serves to connect the ectoderm with the entoderm. Fig. 129 represents a section through the same ovum, and shows a well-developed chorion with typical villi, while the amnion is a small sac closely applied over the beginning embryo. A highly magnified cross-section (Fig. 130) shows the three germ layers and a well-developed somatopleure and splanchnopleure. By the folding of the former it is readily understood how the body walls are formed, and by that of the latter how the primitive gut becomes differentiated from the yolk-sac.

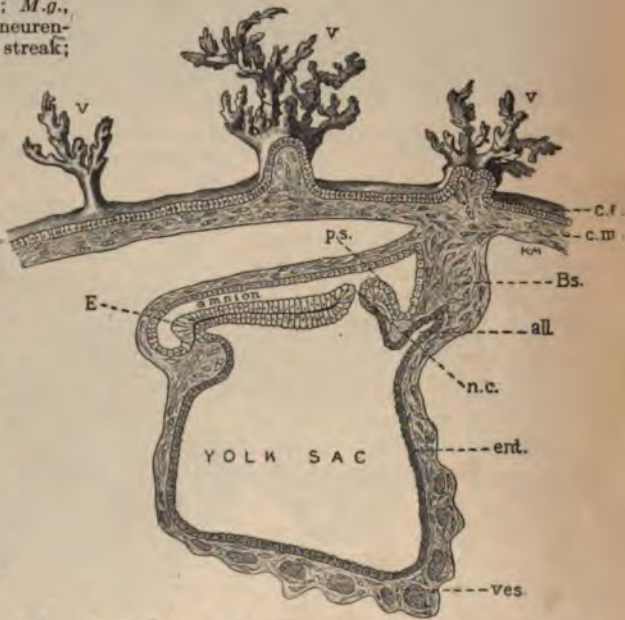
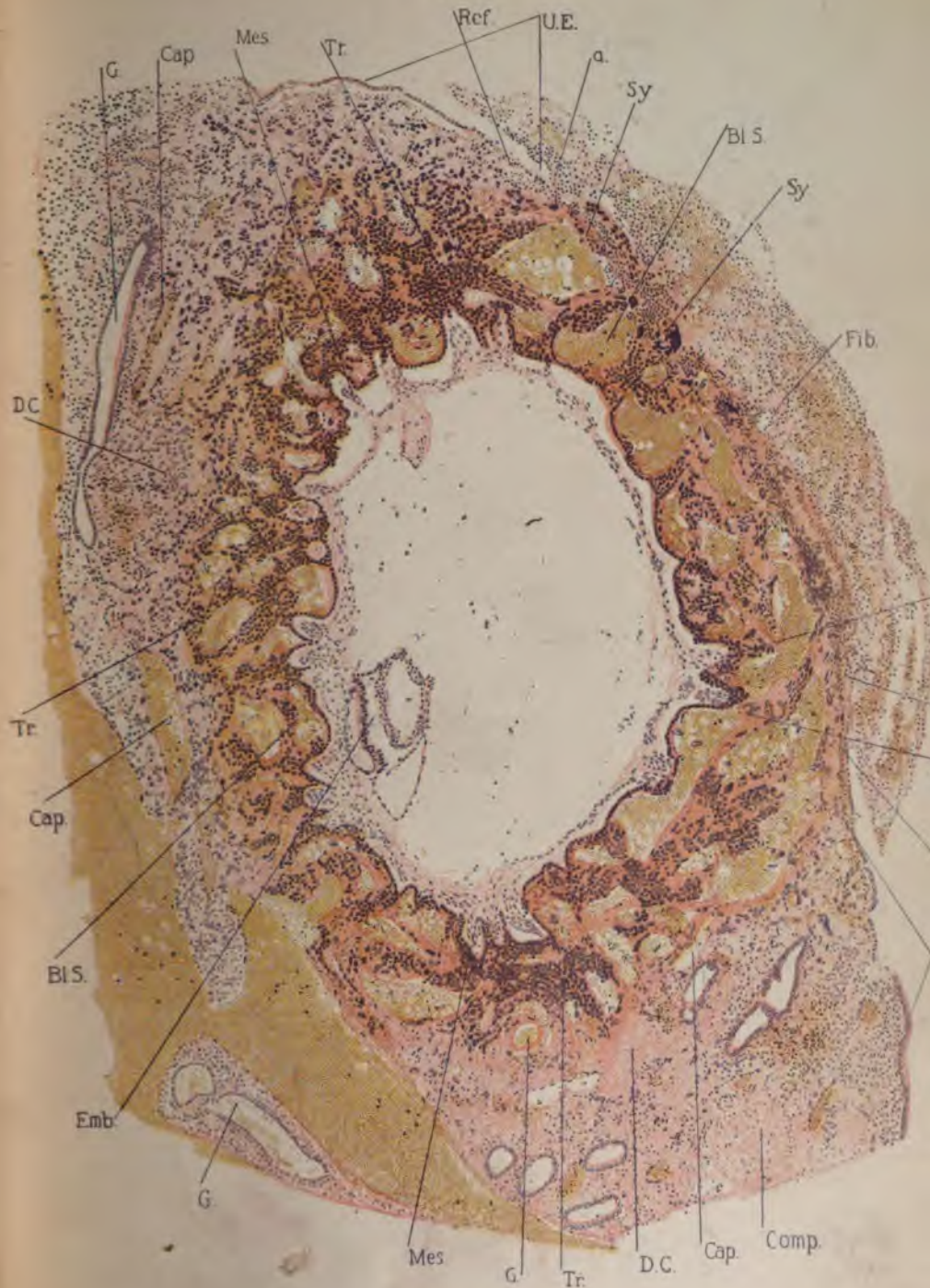


FIG. 129.—SECTION THROUGH HUMAN OVUM, SHOWN IN FIG. 128 (Spee).

all., allantois; c.e., chorionic epithelium; c.m., chorionic mesoderm; Bs., abdominal pedicle; E., beginning embryo; ent., entoderm; n.c., neurenteric canal; p.s., primitive streak; v., chorionic villi; ves., vessels in wall of yolk-sac.



PLATE IV.



PETERS'S OVUM.  $\times 50$ .

*Bl.S.*, blood spaces; *Cap.*, capillary; *Comp.*, compact layer of decidua; *D.C.*, decidual cells; *Emb.*, beginning embryo; *Fib.*, mass of fibrin covering point of entry of ovum into decidua; *Mes.*, connective-tissue layer of chorion; *Ref.*, decidua reflexa; *Syn.*, synechium; *Tr.*, trophoblast; *U.E.*, uterine epithelium.





probably a smooth membranous sac without villi; but in a short time buds of connective tissue make their way into the trophoblast and give rise to rudimentary villi (Figs. 131 and 132 and Plate IV).

Fig. 133 represents a section through the chorion from a three weeks' pregnancy. In it can be distinguished two portions—the chorionic membrane and the villi projecting from it. The chorionic membrane consists of two layers—the inner of connective tissue, the outer of epithelium. Its connective tissue is composed of spindle and



FIG. 130.—SECTION THROUGH SPEE'S OVUM.  
SHOWN IN FIG. 128.

Am., amnion; ect., ectoderm; mes., mesoderm; ent., entoderm;  
M., medullary groove.

star-shaped cells embedded in a mucoid intercellular substance, and at this period does not contain blood-vessels. Its epithelium is arranged in two layers: an inner one adjoining the connective tissue, which is composed of sharply marked cuboidal or roundish cells with clear protoplasm and lightly staining vesicular nuclei, and an outer layer made up of coarsely granular protoplasm, which shows no signs of division into cells, and through which are scattered irregularly shaped, darkly staining nuclei.



FIG. 131.—EARLY HUMAN  
OVUM (Leopold).

Each villus arises from the chorionic membrane as a single stem, which soon gives origin to numerous branches which assume a more or less arborescent form, the complexity of which increases with advancing age. The villi consist of a connective-tissue stroma and an epithelial covering, the former being continuous with and identical in structure with the connective tissue of the chorionic membrane, while the epithelium is composed of the two layers just described.

Projecting here and there from the surface of the villi are epithelial buds, usually consisting of a mass of protoplasm which is not divided into distinct cells, and which, when seen in cross or tangential section, resemble giant cells. These buds indicate proliferation of the outer layer of the chorionic epithelium, and represent the first stage in the development of new villous branches. Here and there, in the spaces between the villi, larger and smaller masses of small, clear cells with vesicular nuclei are seen. They are usually described as *decidual islands*, and were supposed to represent sections through decidual septa, which projected upward toward the chorionic membrane. In reality, however, they are masses of trophoblast which have not been converted into villi.

In early ova the embryo is connected with the connective-tissue layer of the chorion by a mesodermic pedicle, which was first described by His as the *abdominal pedicle* (Bauchstiel), and is the forerunner of the umbilical cord. Through this the umbilical vessels of the embryo make their way to the interior of the chorion, which then becomes vascularized.



FIG. 132.—THREE WEEKS' HUMAN OVUM (Leopold).

In early pregnancy the villi are pretty equally distributed over the periphery of the chorionic membrane, but later they become more abundant over the portion which is in contact with the decidua basalis, the site of the future placenta. This portion of the chorion is designated as the *chorion frondosum*, while the re-

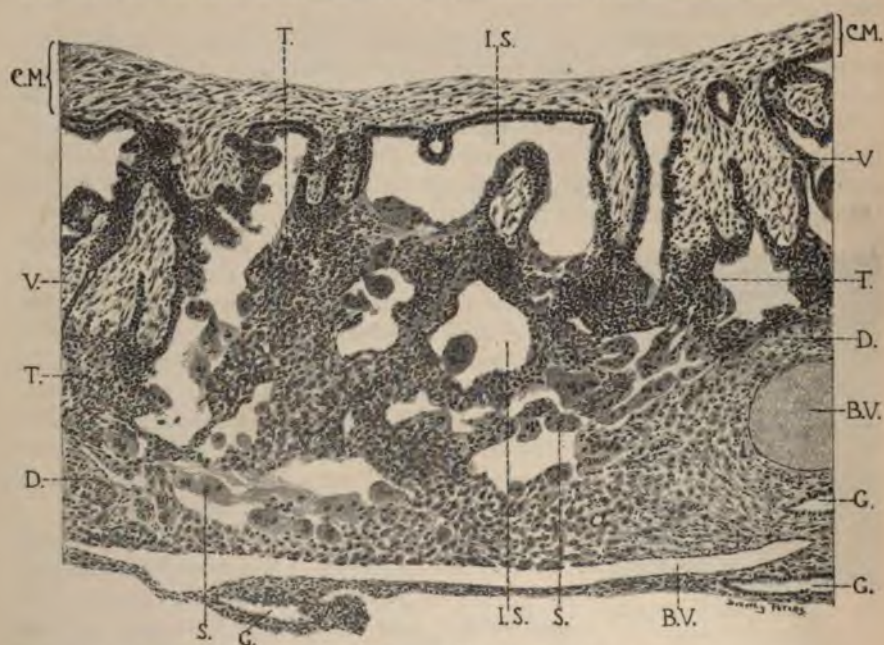


FIG. 133.—SECTION THROUGH THREE WEEKS' HUMAN OVUM, SHOWING CHORION, DECIDUA, AND INTERVILLOUS SPACES.

B.V., maternal blood-vessel; C.M., chorionic membrane; D., decidua; G., uterine gland; I.S., intervillous space; S., syncytium; T., trophoblast; V., villus.

mainder, which is in contact with the decidua reflexa, is termed the *chorion laeve*, since the villi covering it eventually undergo complete degeneration.

A certain number of villi extend from the chorionic membrane to the



underlying decidua, attaching the ovum to it, and hence are designated as *fastening villi*. The majority, however, spring from the chorionic membrane as arborescent structures, whose free endings do not reach the decidua, and which increase in complexity as pregnancy advances.

In early pregnancy the villi are short and plump and represent simply the main stems, but later they give off numerous branches and assume an arborescent appearance. Thus, sections through a young chorion show only a few large villi, while those through an older one are filled with a multitude of smaller branches. This change in appearance is due to the increasing arborescence, and may be compared to what takes place in a clump of trees, which at an early period consists of a number of almost isolated trunks, each of which later gives off innumerable branches and twigs. These differences have been particularly emphasized by De Loos, who has shown that with a little practice one can roughly estimate the age of the chorion by its appearance on section.

The stroma of the villi also varies in appearance according to the age of the chorion. In the earlier stages the cells are branching in shape, and are separated from one another by a large amount of mucoid intercellular substance; later on they become more spindle-shaped and more closely packed together, so that the stroma assumes a denser appearance (Figs. 134 to 136). After the first few weeks blood-vessels appear, and in the



FIG. 134.—CHORIONIC VILLUS, THIRD WEEK.  $\times 225$ .



FIG. 135.—CHORIONIC VILLUS AT FOURTH MONTH.  $\times 225$ .



FIG. 136.—CHORIONIC VILLUS AT TERM.  $\times 225$ .

later months of pregnancy almost displace the stroma, when the arteries present thick walls possessing the typical three layers. The arteries and veins extend to the tips of the villi, where they break up into capillaries, but there is no anastomosis between the vascular supply of the various villi, any more than between the branches of different trees in a forest.

The *epithelium* covering the villi was mentioned by Dalrymple in 1842, but was first definitely described by Langhans many years later. The latter pointed out that it was made up of the two layers already described (Fig. 133). The inner he designated as the *cell-layer* (*Zellschicht*), and it is now generally known as *Langhans's layer*; while the outer layer is usually described as the *syncytium*. This latter term was introduced in 1893 by Kossmann and Merttens, although the characteristics of the tissue had been recognized years before by Kastschenko, who described it as *plasmodium*.

During the first half of pregnancy the two layers are readily distinguished, but in the second half Langhans's layer becomes more and more indistinct, so that at the end of pregnancy the villi are covered only by a single layer of syncytium. Figs. 134, 135, and 136 give



FIG. 137.—TUBAL MUCOSA, SHOWING CONVERSION OF EPITHELIUM INTO SYNCYTIIUM.

Normal epithelium on left, syncytium on right side.

a good idea of the successive changes in the stroma and epithelium of the villi at different ages. Careful examination of properly prepared specimens shows that the outer margin of the syncytium does not present a smooth surface, but is made up of a vertically arranged pseudopodia-like protoplasmic process. These structures are too coarse to be considered as cilia, and are designated by Marchand, Bonnet, Hofbauer, and others as bristle-like processes—"Borstenbesatz."

The origin of the two layers of chorionic epithelium has given rise to a great deal of discussion, but it has been established by the work of Langhans, Kastschenko, Minot, Webster, Heukelom, His, Ruge, Peters, and all recent investigators that they are both derived from the original trophoblastic covering of the ovum, which represents the foetal ectoderm.

Similar conclusions were reached by Hubrecht for the hedgehog, Duval for dogs, Fränkel for many species of animals, and Opitz for the guinea-pig and rabbit, and are now generally accepted.

In 1893 Kossmann advanced the theory that the syncytium was derived from the epithelium of the uterus, while Langhans's layer represented the original foetal ectoderm. His work was apparently confirmed by Merttens a year later, who showed conclusively that a certain amount of uterine epithelium was converted into syncytium, and he thought himself justified in concluding that it grew up over the villi, which up to that time were covered by only a single layer of Langhans's cells or foetal ectoderm, and thus gave

them their second or outer layer. The work of Kossmann and Merttens was very plausibly set forth and accompanied by numerous excellent illustrations, and their conclusions were soon adopted by many authorities, among whom we may mention Marchand and Kollmann. It



would seem, however, that this view is untenable, inasmuch as all recent investigators have shown that the ovum is surrounded by the many-layered trophoblast before the formation of the villi begins, and that the syncytium represents only a modification of it. Still more convincing evidence against its uterine origin is afforded by our present knowledge covering the implantation of the ovum (Figs. 107 and 108). Consequently, it may be positively stated that the syncytial layer of the chorion is not of maternal origin, and that such a view is a relic of old and discarded theories concerning the implantation of the ovum.

On the other hand, it must be admitted that the small areas of uterine epithelium may occasionally assume a distinctly syncytial appearance, and not a few of my specimens confirm this view (Fig. 137). This occurrence, however, must be regarded as exceptional in man, and, even when portions are so converted, satisfactory evidence has not been adduced to show that the tissue forms the syncytial covering of the villi. Furthermore, the formation of syncytium is not necessarily characteristic of pregnancy, and may occur in other conditions, as Gebhard has shown that it may occasionally be observed in carcinoma of the non-pregnant uterus.

The theory of Kossmann and Merttens is only one of a large number which have been advanced in explanation of the origin of the chorionic epithelium. Those who are interested in the subject are referred to the article of Waldeyer, who in 1890 was able to arrange in ten groups the numerous theories which had been advanced up to that time.

#### Structure of the Amnion.

**Amnion.**—In the very earliest stages of pregnancy, as we have already shown (Fig. 109), the amnion is a minute vesicle; later it forms a small sac which arches over the dorsal surface of the embryo, and eventually becomes larger and completely surrounds it. At first the amnion occupies only a small portion of the entire ovum; but as pregnancy advances it increases in size, until eventually it comes in contact with the interior of the chorion and obliterates the extra-embryonic portion of the coelome. When the outer surface of the amnion has supplied itself to the inner surface of the chorion, the two membranes become slightly adherent, but are never very intimately connected, for even at the end of pregnancy they can be readily separated from one another.



FIG. 138.—UTERUS LINED BY DECIDUA, CONTAINING AN EARLY OVUM (Leopold).  $\times 1$ .



From its earliest stages the amnion consists of two layers: an outer layer of mesoderm and an inner layer, made up of cuboidal or flattened, ectodermal cells. The mesodermic layer eventually becomes converted into mucoid-like tissue, which does not contain blood-vessels; while the ectodermal portion changes into a single layer of small cuboidal epithelial cells, which by their origin represent simply an extension of the skin of the embryo. In somewhat more than one-half of all placentæ, at term, small, rounded areas may be observed upon the amnion, particularly in the neighborhood of the attachment of the umbilical cord. Upon microscopical examination they are found to be made up of stratified epithelium, which bears a close resemblance to that of the skin. They are designated as *amnionic caruncles*, and will be considered more fully in the chapter on the pathology of the ovum.

Soon after its formation, a certain amount of clear fluid collects within



Fig. 139.



Fig. 140.

FIGS. 139, 140.—DIAGRAMS ILLUSTRATING HUNTERIAN THEORY OF FORMATION OF DECIDUA REFLEXA.

the amniotic cavity—the amniotic fluid—which increases in quantity as pregnancy advances. The amount varies within wide limits, and according to Fehling averages about 600 cubic centimeters at the end of pregnancy, although under abnormal conditions it may vary from a few cubic centimeters to many liters. Its specific gravity ranges from 1.002 to 1.028, and it contains a certain amount of albumin, urea kreatin, and various salts. Its origin and function will be considered when we take up the physiology of the foetus.

Thus far we have been describing the foetal membranes. Before taking up the study of the placenta, it will be necessary to consider the changes which the endometrium undergoes to prepare it for the reception and nutrition of the ovum.

✓ **Decidua.**—The decidua is the mucous membrane of the uterus which has undergone certain changes under the influence of pregnancy, to fit it for the implantation and nutrition of the ovum. It is so named from the

fact that it is cast off after labor. The older writers usually distinguished between the decidua of menstruation and that of pregnancy, but the employment of the former term is no longer justified, since it has been shown that there is no great loss of tissue at the menstrual period.

The conversion of the uterine mucosa into decidua occurs shortly after the fertilization of the ovum, though we are unable to state exactly when the process commences, inasmuch as the premenstrual swelling is accompanied by marked changes in the structure of the stroma, and more particularly because a fairly well-marked decidua was present in all of the early pregnancies which have thus far been described, being well developed in the specimens of Bryce and Teacher, Peters, and Heine and Hofbauer.

Very shortly after conception the smooth velvety endometrium becomes markedly thicker and its surface is indented by furrows of considerable depth, which give the entire membrane a mamelonated appearance. Under the magnifying-glass numerous small openings can be distinguished which are the mouths of the uterine glands. The decidual formation is limited to the body of the uterus, and does not extend below the internal os, though in rare instances, as in the cases reported by von Franqué, von Weiss, and Volk, isolated decidual cells are found beneath the cervical epithelium.

For purposes of description the decidua is usually divided into several portions: that lining the greater part of the cavity of the uterus being designated as the *decidua vera*; that beneath the ovum as the *decidua serotina*; while the portion which surrounds the ovum and shuts it off from the rest of the uterine cavity is known as the *decidua reflexa*.

The terms *reflexa* and *serotina* date from the time of William Hunter, who gave excellent drawings of the decidual membrane in his atlas. Unfortunately, the author died just after its appearance and before the completion of the explanatory text, which was prepared by John Hunter and Matthew Baillie, who considered that the decidua represented a fibrinous exudate from the lining membrane of the uterus, which formed a complete cast of the uterine cavity and completely covered the tubal openings. They supposed, therefore, that when the ovum reached the uterine end of the tube its further passage was opposed by the decidua vera, which it was obliged to push before it as it entered the uterus, whence the term *reflexa*; and that, after the reflexa had been pushed forward, a new exudate was developed behind the ovum, to which the term *serotina* was applied (Figs. 139 and 140).

This conception was universally accepted until 1846, when Weber in Germany and Sharkey in England demonstrated that the decidua was not an exudate, inasmuch as it contained glandular structures which they identified with the uterine glands. It having therefore become necessary to explain the formation of the reflexa in a different manner, it was assumed that the ovum, on reaching the uterus, found its



Fig. 141.



Fig. 142.

FIGS. 141, 142.—DIAGRAMS SHOWING FORMATION OF DECIDUA REFLEXA (Coste).



# IMPLANTATION, FERTILIZATION, DEVELOPMENT OF OVUM

...by decidua vera, to which it became attached at a point  
...posterior wall somewhere in the neighborhood of the  
...and immediately after its attachment the vera began to pro-  
...form a wall around the ovum, which gradually increased  
...inclosed and surrounded it. More recent investigation,

in turn, showed that this view was not correct, as the ovum in all probability remains upon the surface for only a few hours. Notwithstanding the new ideas concerning the formation of the decidua, the terms reflexa and serotina are still retained, though in the new anatomical nomenclature of His they are more properly designated as the *decidua capsularis* and *basalis* respectively.

**Decidua Vera.**—The microscopic structure of the decidua vera was first studied by Hegar and Maier, but it was not until the work of Friedländer and Kundrat and Engelmann that its structure was definitely understood. Friedländer in 1870 pointed out that the decidua vera was composed of two portions: a *compact* layer superimposed upon a *spongy* or *glandular* layer, the

FIG. 1.

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pregna-  
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although  
meters in-  
it contain-  
Its origin  
of the foetus

Thus far  
up the study  
which the evolu-  
trition of the ovum

**Decidua.**—The  
has undergone  
for the implantation



FOURTH MONTH. X 16.

the muscular wall of the uterus, and forming the membrane. Furthermore, he was of the opinion that the decidua at the time of labor took place at the junction of the decidua vera and decidua capsularis. He showed that the compact layer was made up of polygonal cells, with large, lightly staining, vesicular nuclei; while the spongy layer was composed of the uterine glands. The thickness of the decidua increases markedly in thickness during the first three



or four months of pregnancy, so that at the end of that time it has attained a thickness of about 1 centimeter. Figs. 51 and 143 show very graphically the difference between the normal endometrium and the decidua vera from a uterus four months pregnant. After the fourth month, owing to the marked increase in the size of the uterus, the vera gradually becomes thinner, so that at term it is rarely more than 2 millimeters thick.

Under the microscope the compact layer is seen to be made up of somewhat closely packed, large, round, oval, or polygonal cells, which are distinctly epithelioid in appearance, and possess round, vesicular nuclei, which stain but slightly with the ordinary reagents. When the tissue has been distended by hæmorrhage or œdema, it is seen that many of the decidual cells present a stellate appearance, and are provided with long protoplasmic outgrowths which anastomose with similar processes from neighboring cells. Particularly in the early months of pregnancy, one sees scattered between the typical decidual cells a considerable number of small round cells, whose bodies are almost entirely filled by the nucleus. Such cells were formerly considered as lymphoid in character, but Marchand and Rossi-Doria contend that they are forerunners of new decidual cells, basing their contention upon the fact that they frequently contain mitotic figures, and that all gradations may be observed between them and typical



FIG. 144.—DECIDUA VERA, FOURTH MONTH.  $\times 420$ .

decidual cells. In the early months of pregnancy the ducts of the uterine glands may be seen traversing the compact layer, but they soon disappear, so that in the later months all trace of them is lost.

The spongy layer is made up of the distended and hyperplastic glands of the endometrium, which are separated from one another by a minimal amount of stroma. In many instances the glandular hyperplasia is so marked that the spongy layer suggests an adenoma in appearance. At first

the glands are lined by typical cylindrical uterine epithelium, which, however, gradually becomes more cuboidal in shape and undergoes fatty degeneration, and is cast off in great part into their lumina. A certain amount of epithelium, however, remains intact throughout pregnancy, and from it the endometrium is regenerated after labor. In many instances the stroma between the dilated glands has undergone but little change, and closely resembles that of the non-pregnant uterus.

Under the influence of pregnancy, the surface epithelium covering the decidua gradually loses its cylindrical shape and becomes cuboidal or flattened, sometimes even resembling endothelium. Klein first directed attention to this condition, and held that it was a characteristic microscopic evidence of pregnancy. All subsequent investigators have confirmed his observations.

Fig. 144 represents a section through the compact layer of the decidua vera at the fourth month, while Fig. 145 shows a gland with its surround-

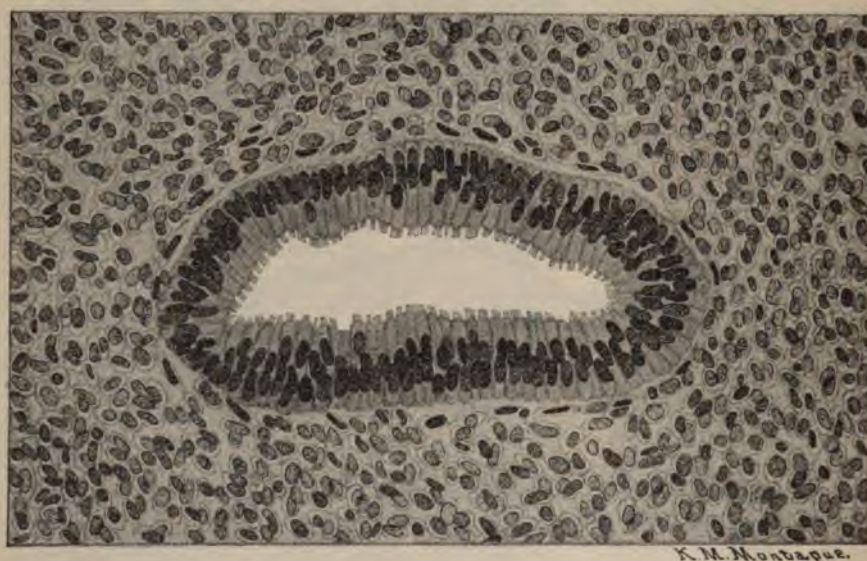


FIG. 145.—GLAND AND STROMA FROM NON-PREGNANT ENDOMETRIUM.  $\times 420$ .

ing stroma from a non-pregnant uterus, drawn under the same magnification. On comparing them, it is readily seen that the decidua differs from the non-pregnant endometrium by a marked increase in size of the stroma cells, and a marked decrease in size of the epithelial cells. Schick in 1905 pointed out that the decidua is particularly rich in lymphatic spaces, and holds that in properly prepared specimens they occupy at least as much space as the hypertrophied glands.

As a result of the work of Hegar and Maier, Leopold, Minot, and others, it is now generally admitted that the decidual cells are derived from the stroma cells of the endometrium, which have undergone marked increase in size, but only slight increase in number. Ruge directed atten-



tion to the resemblance which they bear to sarcoma cells, and stated that "the decidual cell represents the physiological type of the sarcoma cell."

The connective-tissue origin of the decidual cell was established only after prolonged investigation, and has been further reënforced by observations made in certain cases of early tubal pregnancy, in which decidual cells may be seen developing in the smaller folds of the tubal mucosa. In such specimens it is clearly seen that they are derived from the ordinary connective-tissue cells, and result from the hypertrophy of preëxisting units rather than from their proliferation. Furthermore, Schmorl, Kinoshita, Lindelthal, Hörmann, and others have described, in women dying soon after childbirth, small nodules, varying from structures just visible to the naked eye to bodies 1 to 2 millimeters in diameter, which are scattered over the peritoneum, covering the posterior surface of the uterus, Douglas's *cul-de-sac*, and the anterior surface of the rectum, and occasionally also over the ovaries. Schmorl considers that these structures are always found at full-term pregnancy, and has demonstrated that they are made up of decidual tissue. But, whereas they develop beneath the peritoneum, it is evident that they must be derived from connective-tissue cells. I have studied two specimens which showed an unusually wide distribution of decidual formation. In one instance, in which the pregnant uterus was the seat of an adeno-myoma, typical decidual formation was noted in the interglandular tissue of the endometrium-like areas far removed from the uterine cavity; while, in a case of hydatidiform mole, distinct decidual formation was noted not only in the mucosa of the tubes, but also in the connective tissue just beneath their peritoneal covering.

Before the true nature of the decidual cells was definitely proved, various theories were advanced as to their origin: Hennig believing that they were derived from leukocytes, Frommel and Overlach from the uterine epithelium, and Ercolani from the endothelium of the blood-vessels. At the present time these views are of interest only from an historical standpoint.

**Decidua Capsularis.**—Except for the first few hours after its entry into the uterus, the ovum is shut off from the rest of the uterine cavity by the decidua reflexa or capsularis, which forms a capsule of decidual tissue around it. Fig. 138 shows an early pregnancy in which the reflexa is quite apparent, and Fig. 146 a five or six weeks' pregnancy in which it is well developed.

During the early months of pregnancy the decidua capsularis does not entirely fill the uterine cavity, so that a space of varying size exists between it and the vera. This is well shown in Fig. 147, which represents a section through a six to seven weeks' pregnant uterus. At the fourth month of pregnancy, however, the growing ovum entirely fills the uterine cavity, so that the reflexa and vera are brought into intimate contact, and the part of the uterine cavity which had remained unoccupied up to this time becomes obliterated. In a short time the two structures fuse together, when the capsularis gradually degenerates and disappears. This view was first advocated by Minot, and appears to be well founded, inasmuch as sections through the wall of the full-term uterus outside of the placental



site show that the entire decidua is only 2 to 3 millimeters thick, and no trace of the decidua reflexa can be discovered. (See Fig. 152.)

The decidua capsularis usually attains its greatest thickness at about the second month. Sections through it at this time show that it is made up of decidual cells and is covered on its exterior by a single layer of flattened

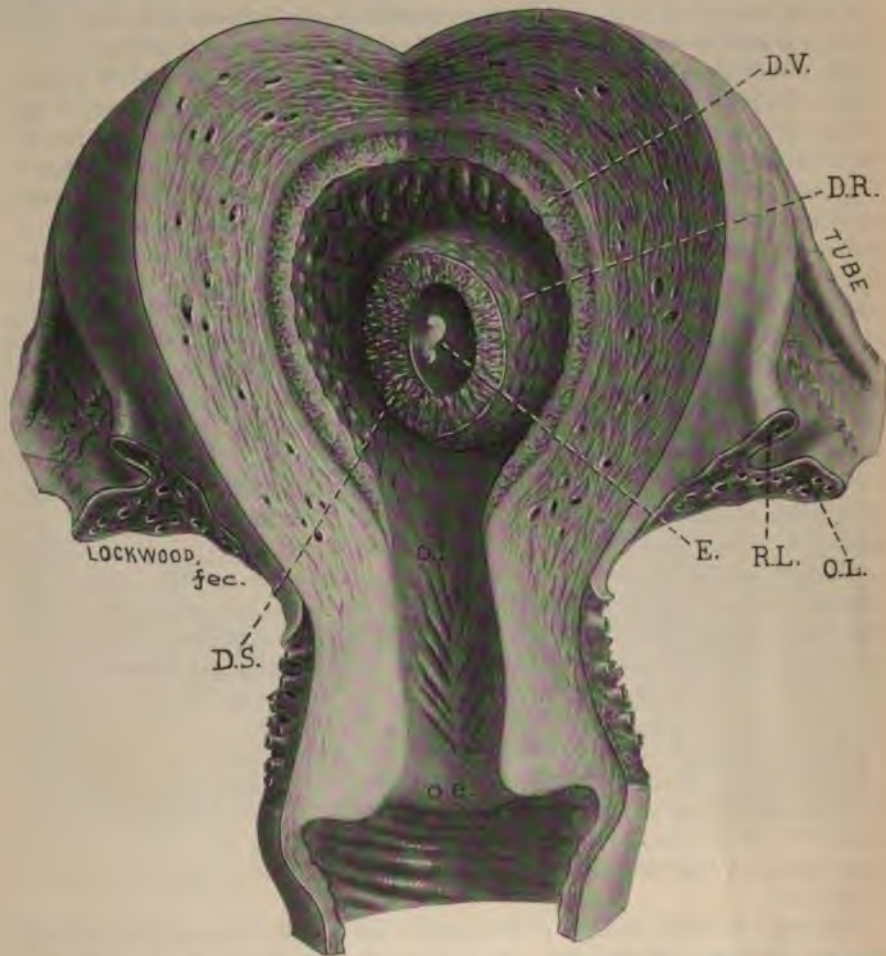


FIG. 146.—FIVE WEEKS' PREGNANT UTERUS.  $\times 1$  (Anatomical Museum, Johns Hopkins University.) Embryo drawn relatively too large.

*D.R.*, decidua reflexa; *D.S.*, decidua serotina; *D.V.*, decidua vera; *E.*, embryo; *O.L.*, ovarian ligament; *R.L.*, round ligament.

or cuboidal epithelial cells; while internally it is in contact with the foetal villi, and at no time shows any trace of uterine epithelium. In its lowest portion, where it is connected with the vera, a few glands may be found, whose ducts, when they are present, are seen to open only upon the outer surface of the membrane.

Up to a few years ago it was universally believed that the capsularis originated from the proliferation of the vera, which grew up around and gradually inclosed the ovum. More accurate knowledge concerning the mode of implantation of the ovum, however, shows that this is not the case, but the capsularis is merely the portion of the decidua which covers the ovum (Fig. 109 and Plate IV).

#### Decidua Basalis.—

The decidua basalis or serotina is the portion of the decidua which lies immediately beneath the ovum; from it the maternal portion of the placenta is developed. Broadly speaking, it presents the same general structure as the decidua vera, except that it has been invaded by foetal tissue, so that its superficial portions are composed of decidual cells and foetal ectoderm.

Friedländer and Leopold stated in their original monographs that giant cells appeared in the basalis about the middle of pregnancy. These, they thought, made their way into the vessels and gave rise to thrombosis. Their interpretation, however, is no longer accepted, and it is now known that the majority of the so-called giant cells are not of decidual origin, but represent portions of trophoblast, which have made their way down into the decidua. Fig. 148, representing a section through the decidua basalis in the last month of pregnancy, shows clearly that its superficial portions are composed of a mixture of both foetal and maternal cells.

In the decidua basalis large numbers of blood-vessels are observed. The arteries pursue a spiral course, and usually penetrate the entire thickness of the membrane; while many of the veins become markedly dilated and form large sinuses. In Fig. 148 two small vessels may be seen which, after pursuing their course through the superficial layer of the serotina, open into the intervillous spaces of the placenta. The consideration of the vascular connections between the foetus and the uterus, however, will be deferred until we take up the study of the placenta.

**Development of the Placenta.**—When the fertilized ovum reaches the uterus it finds the endometrium transformed into decidua in anticipation of its reception. At this time, as has already been pointed out, it is proba-

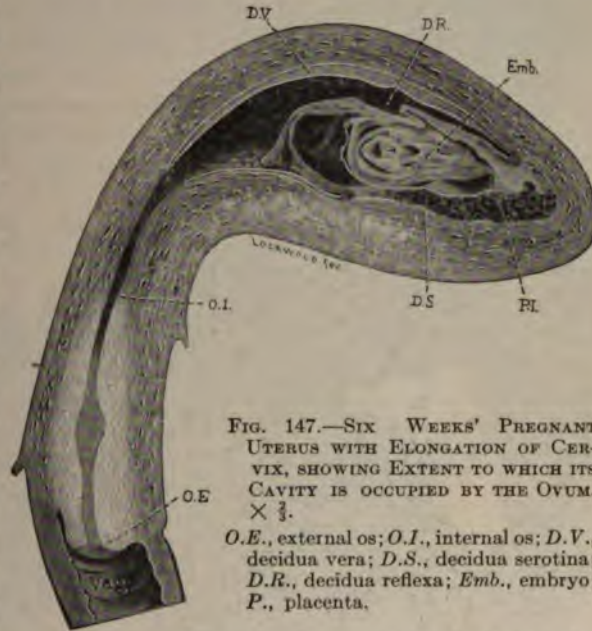


FIG. 147.—SIX WEEKS' PREGNANT UTERUS WITH ELONGATION OF CERVIX, SHOWING EXTENT TO WHICH ITS CAVITY IS OCCUPIED BY THE OVUM.  $\times \frac{3}{4}$ .

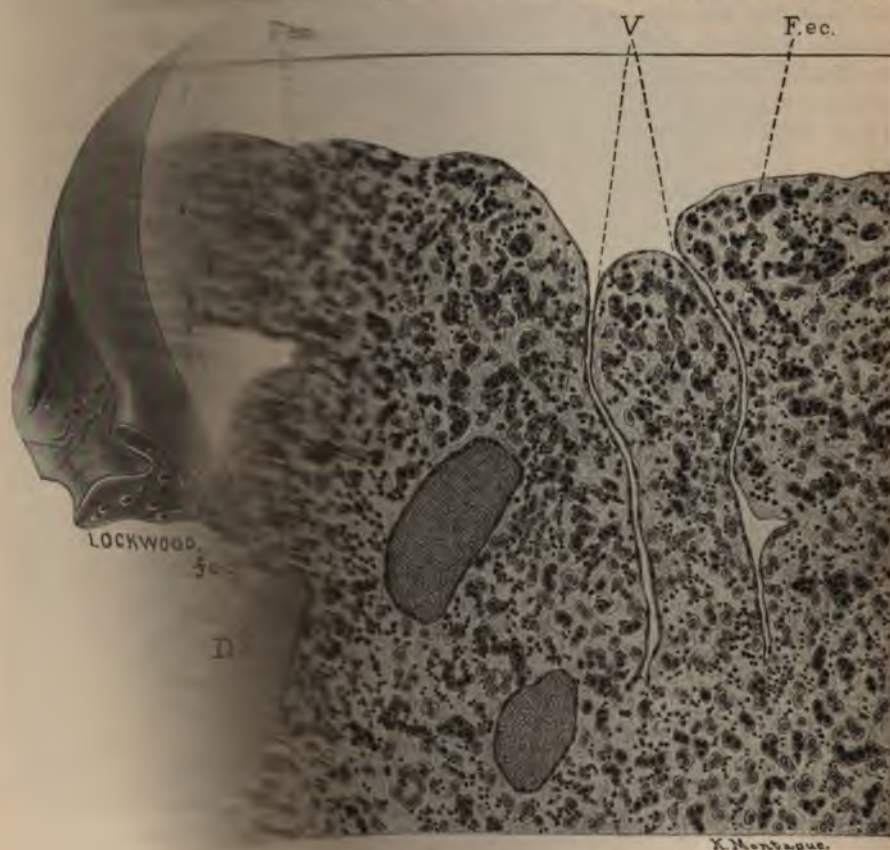
O.E., external os; O.I., internal os; D.V., decidua vera; D.S., decidua serotina; D.R., decidua reflexa; Emb., embryo; P., placenta.



site show that it certainly has not advanced beyond that of the trace of the decidua, and that it does not possess villi. Its exterior is formed

The decidua, which soon becomes converted into the many-second month.

decidual cells becomes attached to the decidua vera covering the anterior or posterior wall of the uterus, and only excep-



SHOWING MIXTURE OF FOETAL AND MATERNAL CELLS.  $\times 75$ .

D.R., decidua reflexa; V., vessel; F.ec., foetal ectoderm.

FIG. 146.—FIVE WEEKS. portion of the uterine cavity. It is very rarely seen, since these present only a slight decidual reaction, and are confined to the anterior and posterior walls. At present we are concerned with the factors which cause the arrest of the embryo. Its mode of implantation has already been considered. At our disposal there is no doubt that the embryo sinks into the uterine epithelium, and sinks down into the decidua. In the guinea-pig (Figs. 107 and 108). In the guinea-pig the ovum becomes completely surrounded by the decidua, separating it from the uterine cavity



being known as the capsularis, and that beneath it as the basalis. Almost immediately its trophoblast begins to proliferate and invade the surrounding decidual tissue, as was shown by the work of Hubrecht, Heukelom, and Peters. As it does so, it breaks through the walls of maternal capillaries, from which the blood escapes and forms cavities, which are bounded partly by trophoblast and partly by decidua (Plate IV). As the process goes on more vessels are opened up, so that in a short time the trophoblast presents a sieve-like appearance due to the presence of large numbers of blood spaces filled with maternal blood. As a result, the trophoblastic cells become compressed into irregularly shaped masses of varying size, some of which extend from the surface of the ovum to the surrounding decidua, and afford the epithelial basis from which the villi are developed.

The maternal blood spaces established in this manner represent the earliest stages in the formation of the *intervillous blood spaces* of the future placenta, and are abundantly present in all of the early ova recently studied. Coincidentally with their formation, the irregularly shaped masses of trophoblast are invaded by connective-tissue offshoots from the chorionic membrane, and are thus converted into *villi*. The cells surrounding them become arranged in two layers, the inner corresponding to Langhans's layer, the outer one being composed of syncytium.

As already indicated, a considerable number of the primary villi extend from the periphery of the chorionic membrane to the surrounding decidua, while the majority project freely into the blood spaces. The former are designated as *fastening villi* (Haftzotten), and serve to attach the ovum to the decidua. Where they come in contact with the latter, the trophoblast at their tips, which is now designated as chorionic epithelium, undergoes marked proliferation, and like the roots of a tree invades the decidual tissue still further, until the two structures become firmly united. The proliferated trophoblast may be observed in placenta in all stages of development, and is represented by what are usually known as the *cell nodes* or *cell columns*, which are made up of Langhans's cells. Their formation was carefully studied by Heukelom in the early ovum which he described.

During the first few weeks of pregnancy branching villi project from the entire periphery of the ovum, as is well seen in the figures taken from Leopold's work. They come in contact not only with the decidua basalis, but also with the capsularis, so that intervillous blood spaces surround the entire ovum. During the first few weeks the chorionic villi are devoid of blood-vessels, and the ovum is nourished by osmosis from the maternal fluids.

As pregnancy advances, the blood supply of the decidua basalis becomes more and more abundant, while that of the capsularis is diminished; as a consequence the villi in contact with the former are better nourished and begin to grow more luxuriantly, the process thus leading to the formation of the placenta. At the same time, the other villi develop less rapidly, and eventually atrophy, so that the portion covered by them becomes known as the *chorion laeve*. As the ovum increases in size, the intervillous spaces in the chorion laeve become smaller and smaller, and by the fourth month, when the decidua reflexa has come in contact with the vera, they be-

## 132 MATURATION, FERTILIZATION, DEVELOPMENT OF OVUM

come obliterated, and the villi which project into them undergo almost complete degeneration. In sections through the foetal membranes at term (Fig. 152) the chorion laeve consists of several layers of epithelial cells, which represent the chorionic epithelium, and through which are scattered, here and there, round or oblong hyalin bodies, in which a few spindle-shaped nuclei can be distinguished. These are the remains of the earlier villi. At the same time degenerative changes take place where the epithelium of the chorion laeve comes in contact with the decidua tissue, which result in the formation of a fibrin-like material which will be considered in detail a little later.

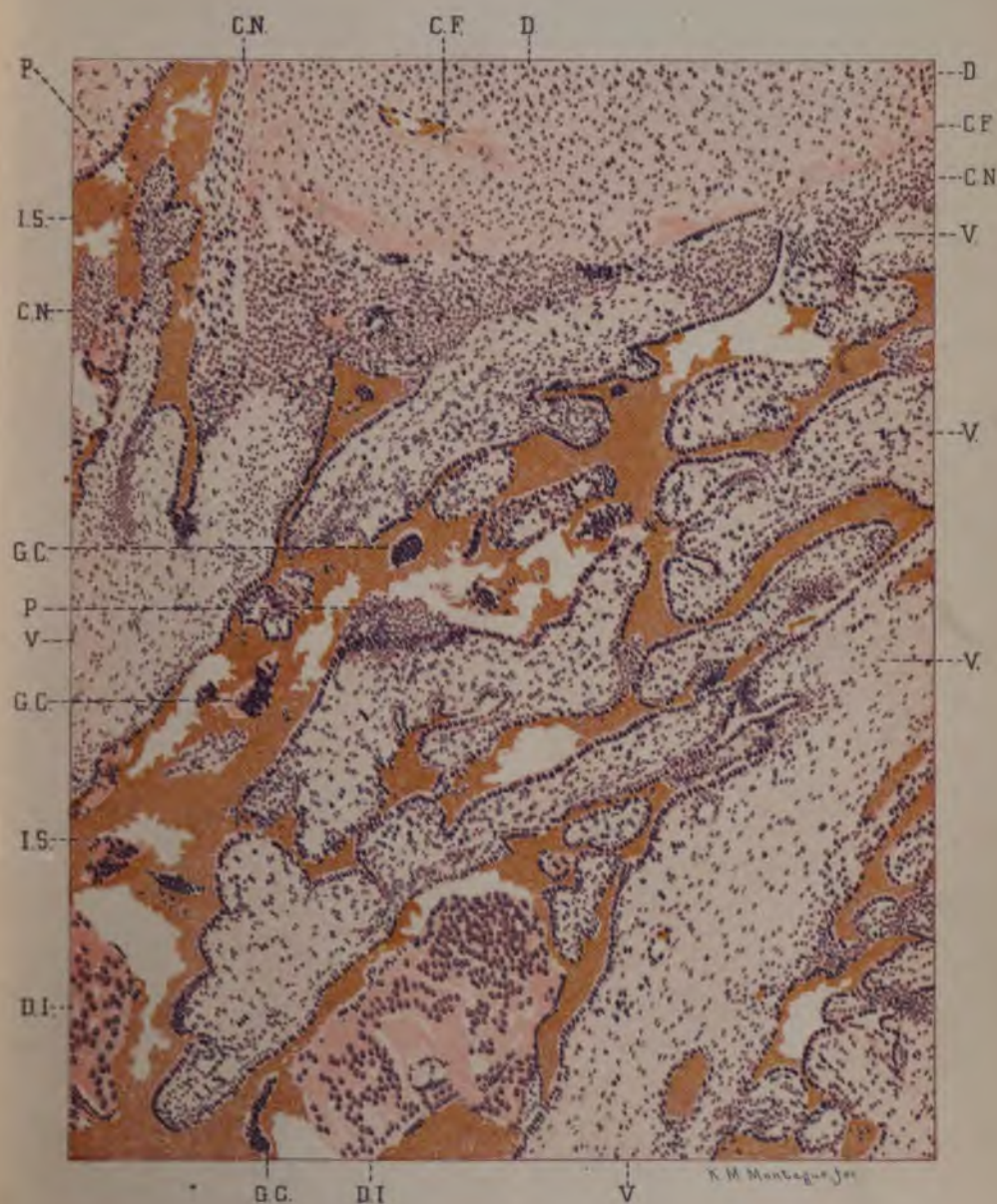
On the other hand, the villi of the chorion frondosum increase in size and number, and become vascularized by branches of the umbilical vessels of the embryo, so that after the first few weeks the foetal circulation extends to the tips of the smallest villi.

The *placenta* is formed by the union of the chorion frondosum and the decidua basalis, and therefore is composed of foetal and maternal tissues. It soon constitutes a distinct structure, although its site is indicated at a much earlier period by the increased thickness of the chorion at that point. According to Benoist, its weight exceeds that of the foetus for the first three and a half months of pregnancy.

We can probably best understand the structure of the placenta by studying sections through it at various points of pregnancy. One from the fourth month is reproduced in Plate V, and shows that the organ is made up in great part of chorionic villi, whose stroma presents a somewhat mucoid appearance, and contains spindle- and star-shaped connective-tissue cells, between which well-developed arteries, veins, and capillaries may be observed. At this stage the villous epithelium is arranged in two layers—Langhans's layer and the syncytium—and from the latter many buds protrude, which, when seen in cross or tangential section, appear as giant cells lying free in the intervillous spaces.

In the upper part of the plate is the decidua basalis, with which some of the larger fastening villi are connected. At their ends can be noted a marked proliferation of ectodermal cells, which invade the underlying decidua, giving rise to the *cell nodes* or *cell columns*, and corresponding to the trophoblastic formation of the early days of pregnancy. The cell nodes are composed almost exclusively of Langhans's cells, as the syncytium does not follow them down into the depths of the decidua. The spaces between the chorionic membrane and the decidua, as well as those between the villi themselves, are designated as the *intervillous spaces*. These are filled with maternal blood and their walls are lined by syncytium. Scattered through them are isolated giant cells—the so-called placental giant cells—whose origin has already been considered. Here and there are seen a few large areas composed of cuboidal or polygonal cells with vesicular nuclei, which frequently present marked signs of degeneration. These are the so-called *decidual islands*, and are usually supposed to represent sections through decidual septa, which project upward from the surface of the decidua serotina toward the chorionic membrane. But, as has already been pointed out, most of them are masses of trophoblast, into

PLATE V.



SECTION THROUGH FOUR MONTHS' PLACENTA, SHOWING JUNCTION OF CHORION AND DECIDUA.  $\times 56$ .

*C. F.*, canalized fibrin; *C. N.*, cell nodes; *D.*, decidua serotina; *D. I.*, decidual island; *G. C.*, giant cell; *I. S.*, intervillous space; *P.*, proliferating villous epithelium; *V.*, chorionic villi.





which the chorionic connective tissue has not grown, and which therefore have not developed into typical villi.

At the junction between the cell nodes and the decidual tissue areas are noted which stain deeply with eosin, and which, on closer examination, are seen to be made up of fibrin, honeycombed in various directions by small spaces—the so-called *canalized fibrin*—which probably results from the degeneration of foetal and decidual cells. This is known as Nitabuch's fibrin layer, from the author who first called attention to its presence in the decidua. Its existence has been confirmed, and its characteristics have been studied by Langhans, Rohr, Tussenbroeck, Ulesko-Stroganowa, and others, and it is generally considered to mark the border line between the foetal and maternal tissues.

It would seem that degenerative changes occur wherever foetal and maternal tissues come in contact, and the phenomenon suggests the possibility that the function of the decidua may not merely be to afford a suitable structure for the implantation and nutrition of the ovum, but also to protect the maternal organism against invasion by foetal cells.

Until comparatively recently the participation of foetal tissue in the decidua basalis was not recognized, and when foetal cells were found beneath the chorionic membrane they were considered as being of decidual origin. Accordingly, Winckler and other observers believed that decidual tissue extended from the margins of the decidua basalis over the whole of the maternal surface of the chorionic membrane, so that the entire intervillous space was included between decidual and maternal tissue. Winckler designated the superficial portion of the decidua as the *basal*, and the portion covering the chorionic membrane as the *closing* plate of the decidua. We have already shown that the tissue in question is composed of foetal ectoderm, and the conception of decidual plates should therefore be abandoned.

At one point (Plate V) a maternal vessel is seen which, after reaching the surface of the decidua, opens directly into the intervillous spaces. At present it is universally admitted that the blood in these spaces is exclusively maternal in origin.

The foetal blood in the vessels of the chorionic villi at no time gains access to the maternal blood in the intervillous spaces, the two being separated from one another by the double layer of chorionic epithelium, a portion of the stroma of the villus, and the vessel walls (Plate VI).

At the point marked "P" in Plate V, a villus is seen whose tip projects into the lumen of a uterine vein, and in many instances the ends of such villi grow for a considerable distance into vessels. Veit has pointed out that in such cases portions of villi may become broken off, and thus gain access to the general circulation. He designates the process as *deportation*, and upon it has constructed an extensive theory concerning many of the abnormalities of pregnancy, to which reference will later be made.

#### **Structure of Placenta in Latter Half of Pregnancy and at Full Term. —**

Except in its increased size, the placenta in the second half of pregnancy differs but slightly from that of the fourth month. Microscopic sections at this period, however, show certain points of difference. These are well





which the chorionic connective tissue has not grown, and which therefore have not developed into typical villi.

At the junction between the cell nodes and the decidua areas are noted which stain deeply with eosin, and which, on closer examination, are seen to be made up of fibrin, honeycombed in various directions by small spaces—the so-called *canalized fibrin*—which probably results from the degeneration of foetal and decidua cells. This is known as Nitabuch's fibrin layer, from the author who first called attention to its presence in the decidua. Its existence has been confirmed, and its characteristics have been studied by Langhans, Rohr, Tussenbroeck, Ulesko-Stroganowa, and others, and it is generally considered to mark the border line between the foetal and maternal tissues.

It would seem that degenerative changes occur wherever foetal and maternal tissues come in contact, and the phenomenon suggests the possibility that the function of the decidua may not merely be to afford a suitable structure for the implantation and nutrition of the ovum, but also to protect the maternal organism against invasion by foetal cells.

Until comparatively recently the participation of foetal tissue in the decidua basalis was not recognized, and when foetal cells were found beneath the chorionic membrane they were considered as being of decidua origin. Accordingly, Winckler and other observers believed that decidua tissue extended from the margins of the decidua basalis over the whole of the maternal surface of the chorionic membrane, so that the entire intervillous space was included between decidua and maternal tissue. Winckler designated the superficial portion of the decidua as the *basal*, and the portion covering the chorionic membrane as the *closing* plate of the decidua. We have already shown that the tissue in question is composed of foetal ectoderm, and the conception of decidua plates should therefore be abandoned.

At one point (Plate V) a maternal vessel is seen which, after reaching the surface of the decidua, opens directly into the intervillous spaces. At present it is universally admitted that the blood in these spaces is exclusively maternal in origin.

The foetal blood in the vessels of the chorionic villi at no time gains access to the maternal blood in the intervillous spaces, the two being separated from one another by the double layer of chorionic epithelium, a portion of the stroma of the villus, and the vessel walls (Plate VI).

At the point marked "P" in Plate V, a villus is seen whose tip projects into the lumen of a uterine vein, and in many instances the ends of such villi grow for a considerable distance into vessels. Veit has pointed out that in such cases portions of villi may become broken off, and thus gain access to the general circulation. He designates the process as *deportation*, and upon it has constructed an extensive theory concerning many of the abnormalities of pregnancy, to which reference will later be made.

#### Structure of Placenta in Latter Half of Pregnancy and at Full Term. —

Except in its increased size, the placenta in the second half of pregnancy differs but slightly from that of the fourth month. Microscopic sections at this period, however, show certain points of difference. These are well



Fig. 149. *V. M. Montagu, Jr.*

illustrated in Fig. 149, which represents a section through a seven and a half months' placenta and the adjacent uterine wall. Studying it from below upward, we see that it is composed of the following structures: amnion, chorionic membrane, villi, intervillous blood spaces, and decidua basalis.

The amnion covers the inner or foetal surfaces of the placenta, and consists of a single layer of cuboidal epithelium, below which comes a layer of more or less fibrillar connective tissue, containing no blood-vessels. The chorionic membrane presents essentially the same structure as in the earlier months of pregnancy, differing only in the presence of a large amount of canalized fibrin immediately beneath its epithelium.

The great bulk of the placenta is made up of chorionic villi, which are much more abundant, but at the same time considerably smaller, than at the fourth month. Their stroma, which is made up of spindle-shaped cells, is denser in appearance, is occupied in great part by blood-vessels, and differs markedly from the mucoid tissue of the earlier months. These changes have already been referred to, and are clearly shown in Figs. 135 and 136.

The epithelium covering the villi has also undergone marked change; Langhans's layer has almost completely disappeared and only a thin layer of syncytium re-

FIG. 149.—SECTION THROUGH PLACENTA AT EIGHTH MONTH.  $\times 15$ .

PLATE VI.



TERMINAL CHORIONIC VILLUS, WITH INJECTED VESSELS.



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through the inter-communicating intervillous spaces, though it is necessarily more sluggish than elsewhere in the body.

The nature of the *intervillous spaces* and the question as to whether they contained maternal blood have given rise to a great deal of discussion. Vater, Noortwyk, and William and John Hunter, in the eighteenth century, expressed an affirmative opinion; and the last two investigators conclusively demonstrated it by injection experiments. Similar results were obtained by E. H. Weber in 1842. But this work was gradually lost sight of, and all sorts of theories were evolved concerning their nature and contents. Braxton Hicks, Ercolani, and others believed that they did not contain blood, but some substance derived from the mucous membrane of the uterus which they designated as *uterine milk*.

Correct conceptions as to the nature of the placenta were finally established by the work of Farre, Turner, Waldeyer, Nitabuch, Rohr, Bumm, Leopold, and others, who showed conclusively that the intervillous spaces contained maternal blood, and that vessels from the mother could be traced into them. This was especially well demonstrated by Waldeyer, who, in five pregnant cadavers, was able to inject them from the maternal vessels. Furthermore, the recent work of Peters, Leopold, and others has placed the question beyond all reasonable doubt.

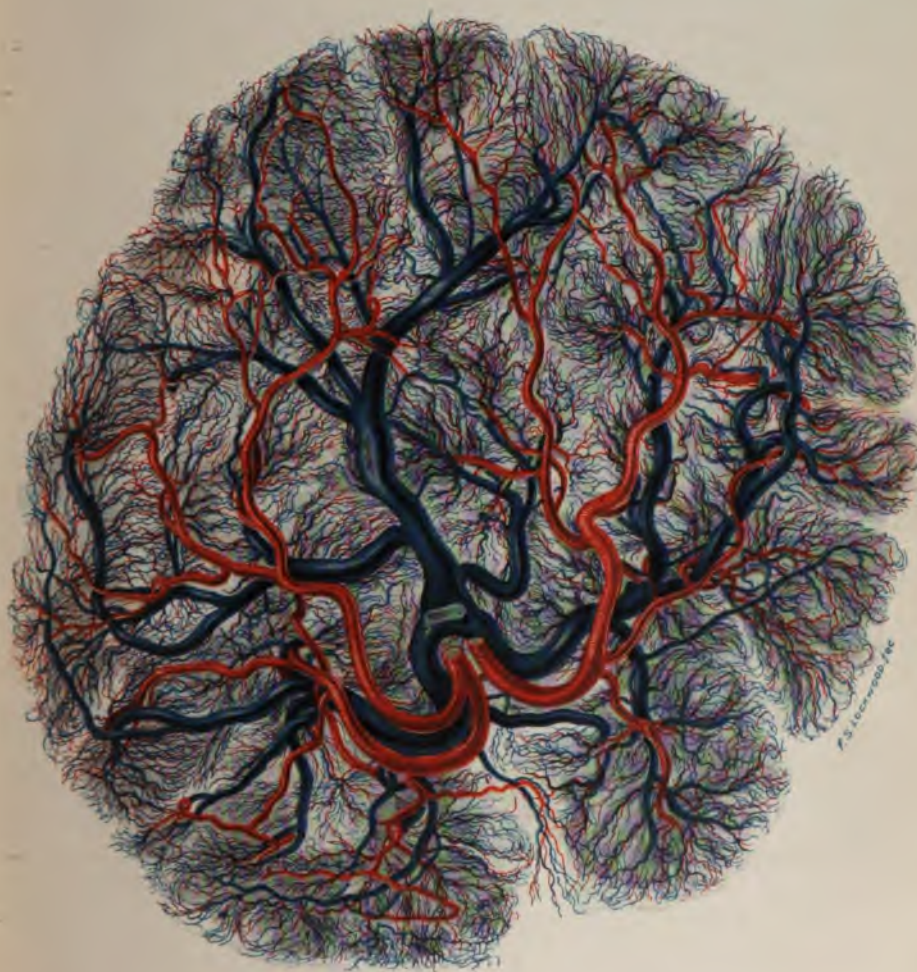
In view of these facts, then, the placenta must be regarded as a collection of maternal blood, included between the chorionic membrane and the decidua basalis, into which the villi dip and by which they are surrounded. Some idea of the complexity of its vascular arrangement may be gained from Plate VII, which represents a corrosion preparation of the foetal portion of a full-term placenta, which was injected through the umbilical arteries and veins with red and blue celloidin. (Also see Plate VI.)

Normally there is no communication between the foetal blood contained in the chorionic villi and the maternal blood in the intervillous spaces, and it would appear that the transmission of substances from one to the other is accomplished partly by osmosis and partly by the direct cellular activity of the syncytium, the process being analogous to that which takes place in the tubules of the kidney and other organs. The effete materials from the foetus are carried by the umbilical arteries to the capillaries of the terminal villi, whence they are transmitted to the maternal blood in the manner just described. At the same time the oxygen and the materials needed for the nutrition of the foetus are taken up from the former and carried by the umbilical vein to the foetus. Thus, in a general way, we may say that the placenta represents the lungs, stomach, and excretory organs of the unborn child.

**The After-birth.**—The placenta, as it is cast off from the uterus after the birth of the child, is a flattened, roundish, or oval organ—15 to 18 centimeters in diameter, and 2 to 3 centimeters in height at its thickest part—from the margins of which the membranes extend. Ordinarily its weight is about  $\frac{1}{6}$  of that of the foetus, so that when the latter is normally developed the placenta weighs from 500 to 600 grams.

It presents for examination two surfaces and a margin—the surface

PLATE VII.



CORROSION PREPARATION OF MATURE PLACENTA, TO SHOW FETAL  
VESSELS.  $\times \frac{3}{4}$ .







FIG. 150.—MATERNAL SURFACE OF MATURE PLACENTA, SHOWING COTYLEDONS; MEMBRANES TURNED BACK.  $\times \frac{2}{3}$ .



FIG. 151.—FETAL SURFACE OF MATURE PLACENTA.  $\times \frac{2}{3}$ .  
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in contact with the decidua basalis being designated as the maternal or outer, and that directed toward the cavity of the ovum as the foetal or inner surface. The former is covered by a thin layer of decidua and presents a ragged, torn appearance, being divided by depressions of varying depth into a number of irregularly shaped areas, the so-called *cotyledons*, which vary considerably in number, as many as twenty being sometimes observed. On careful examination of the decidual surface, numerous ves-

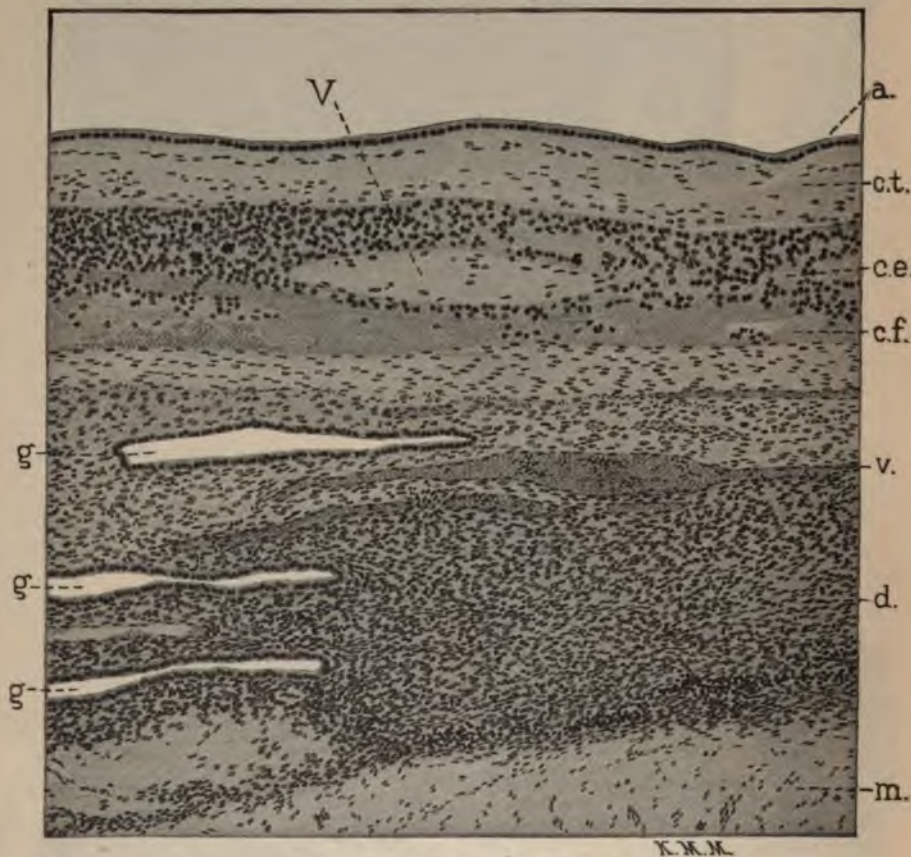


FIG. 152.—FETAL MEMBRANES AND UTERINE WALL.  $\times 75$ .

*a.*, amnion; *c.t.*, connective tissue of amnion and chorion; *c.e.*, chorionic epithelium; *c.f.*, canalized fibrin; *d.*, decidua; *g.*, gland; *m.*, muscularis; *v.*, vein; *V.*, atrophic villus.

sels may be seen which have been torn through when the placenta was separated. Thus, Klein was able to count 51 arteries and 53 veins in a single specimen.

The foetal or inner surface presents a glistening appearance, owing to the fact that it is covered by amnion, which, however, is only slightly adherent. When the latter is removed it leaves a coarsely granular surface, upon which the umbilical cord is usually inserted somewhat eccentrically, though it may be just at the center of the organ and occasionally near its



margin. The various modes of insertion will be considered when we take up the abnormalities of the placenta.

The vessels composing the umbilical cord spread out beneath the amnion and rapidly divide, but the main branches remain upon the foetal surface of the placenta until its margin is reached. In many instances a large vein, which is usually known as the *circular sinus*, extends around a considerable portion of the periphery of the placenta, but only in very rare cases completely encircles the organ.

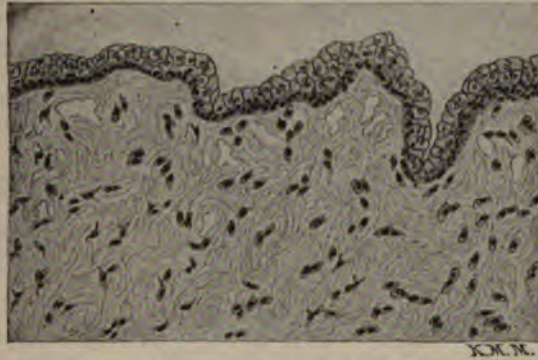


FIG. 153.—EPITHELIUM OF UMBILICAL CORD.  $\times 110$ .

The *fœtal membranes* consist of the amnion, chorion, and a thin layer of decidua. The amnion, the innermost of the membranes, is a thin, transparent, glistening structure, which is rarely thicker than a sheet of



FIG. 154.—UMBILICAL CORD, FœTAL END.  $\times 5\frac{1}{2}$ .  
U.A., umbilical artery; U.S., remnant of umbilical stalk; U.V., umbilical vein.

writing paper. Its outer surface is closely applied to the chorion, from which, however, it can usually be separated without difficulty. The chorion is more opaque and thicker than the amnion, though it rarely exceeds 1 millimeter in thickness. It represents the chorion lœve of the early months, and under the microscope is seen to possess a number of degenerated villi. Clinging to its outer surface are a few shreds of tissue—the portion of the decidua which is cast off after the birth of the child. Fig. 152 is taken from a section through the fœtal membranes and the uterine wall outside of the placental site, and gives a good idea of their composition.

**Umbilical Cord.**—The umbilical cord, or funis, extends from the navel of the child to the foetal surface of the placenta. Its exterior presents a



dull white, moist appearance, and through it shimmer the umbilical vessels—two arteries and a vein. It varies from 1 to 2.5 centimeters in diameter, and averages about 55 centimeters in length; though in extreme cases it may vary from 0.5 to 198 centimeters. The average length of 1,000 cords, which were measured

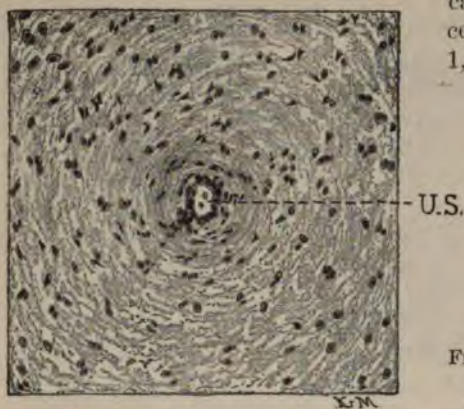


FIG. 155.—SECTION THROUGH UMBILICAL CORD, SHOWING STALK OF UMBILICAL VESICLE.  $\times 110$ .



FIG. 156.—SECTION THROUGH ABDOMINAL PEDICLE OF 2.25-MILLIMETER EMBRYO (His).  $\times 50$ .

All., allantois; M.G., medullary groove; U.A., umbilical artery; U.V., umbilical vein.

at the Johns Hopkins Hospital, was 55 centimeters, the shortest being 12 and the longest 100 centimeters.

The cord frequently presents a twisted appearance, the coiling usually being from left to right. As the vessels are usually longer than the cord, they are frequently folded upon themselves, thus giving rise to nodulations upon the surface which are designated as false knots.



FIG. 157.—SECTION THROUGH YOUNG UMBILICAL CORD (Midot).

A., artery; All., allantois; U.S., stalk of umbilical vesicle; V., vein.



FIG. 158.—STALK OF UMBILICAL VESICLE BEING INCLUDED IN THE UMBILICAL CORD (His).

The cord is covered by several layers of epithelium, which is a direct continuation of the skin covering the abdomen of the embryo; its interior is made up of a mucoid connective tissue—the so-called Whartonian jelly.

Microscopic sections through the foetal and placental ends of the cord at term present a somewhat different appearance. In the former, besides the vessels, one usually sees two small, darkly staining areas, which under higher magnification appear as small ducts lined by cuboidal or flattened epithelial cells. One is the remnant of the allantois, and the other the duct or stalk of the umbilical vesicle; at the placental end only the latter is present.

In most text-books it is stated that the cord is derived from the allantois, and is covered by a sheath of amnion. The researches of His have definitely shown that such is not the case in man, but that the foetus, in the earliest stages of pregnancy, is connected with the inner surface of the chorion by a tolerably thick mass of tissue, only a small portion of which is occupied by the allantois. This he designated as the abdominal pedicle (*Bauchstiel*), and showed that it represents merely an extension of the caudal end of the embryo.

Fig. 156 represents a section through the abdominal pedicle of one of the early embryos studied by His, and clearly shows its analogy with the embryonic area. The great bulk of the structure is made up of mesodermic tissue in which the umbilical vessels and the allantois are embedded; its dorsal surface is covered by a single layer of ectoderm, showing at its middle a slight depression which represents a continuation of the medullary groove, while arching over it is the amnion. In its further development the ectodermal portion, corresponding to the somatopleure, extends downward and inward, eventually inclosing a small portion of the coelome in a way similar to that in which the abdominal walls are formed in the embryo itself. In this cavity the stalk of the umbilical vesicle or yolk-sac is included. In the meantime the amnion is likewise extending around the entire structure, but is not in contact with it; and as the former becomes more and more distended by the amniotic fluid, it becomes farther and farther separated from the abdominal pedicle, or, as we may now call it, the umbilical cord. Eventually the amnion is connected only with the portion of the cord which is attached to the foetal surface of the placenta.

Fig. 158 represents a thirty days' embryo described by His, and gives a very good idea of the manner in which the stalk of the umbilical vesicle becomes included within the cord.

**Umbilical Vesicle.**—The yolk-sac, or, as it becomes later, the umbilical vesicle, is a very prominent organ at the beginning of pregnancy, and is present in all early ova. In its earliest stages it occupies a great part of the interior of the blastodermic vesicle. But, as the embryo develops, it becomes relatively smaller, and, as we have already shown, is taken up in great part to form the intestinal canal, so that after the formation of the abdominal walls it protrudes from the umbilicus into the coelomic cavity as a rounded sac with a distinct stalk. As pregnancy advances the sac becomes smaller and its stalk longer.

The structure persists throughout pregnancy, and can nearly always be found at full term, when it is represented by a small oval sac, 3 to 5 millimeters in diameter, which usually lies on the foetal surface of the placenta, between the chorion and amnion, but occasionally in the mem-

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branes just beyond the placental margin. It is connected with the umbilical cord by a fine pedicle, which, as has been already indicated, may be seen in sections through the cord at term. Schultze in 1861 was able to demonstrate the umbilical vesicle in 146 out of 150 mature placenta examined. Meyer has found that the vesicle may attain considerable proportions, it being 10 to 15 millimeters in diameter in several instances.

The intra-abdominal portion of the duct of the umbilical vesicle, which extends from the umbilicus to the intestine, usually atrophies and disappears, but occasionally it remains patent, forming what is known as *Meckel's diverticulum*, which may play an important pathological part in later life.

In animals whose ova possess a large amount of yolk the umbilical vesicle is the main source of nutrition for the embryo; but in women its significance is not so clear, since the proportion of yolk is exceedingly small. In some of the lower animals it affords a means of vascularizing the chorion while in still others it takes part in the formation of an accessory placenta, in addition to the main one which is vascularized from the allantois. It must, however, play an important part in the economy of the embryo, as it develops a considerable circulation, and, as Selenka has shown, forms numerous crypts from its entodermal lining. As yet we are unacquainted with its functions.

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## CHAPTER V

### THE FŒTUS

**The Fœtus in the Various Months of Pregnancy.**—It is a matter of considerable importance that the physician be able to tell approximately the age of embryos and prematurely born children, and we shall therefore give a short description of the fœtus at its various periods of development.

The average duration of pregnancy, from the commencement of the last menstrual flow to the onset of labor, is two hundred and eighty days, or ten lunar months, though a considerable number of children are born shortly before or after the expiration of that period.

The following details concerning the development of the unborn child are taken in great part from His, who distinguished three periods in its evolution. Thus, during the first two weeks of pregnancy the product of conception is designated as the ovum; from the third to the fifth week—the period during which the various organs are developed and a definite form is assumed—it is known as the embryo; after the fifth week it becomes the fœtus.

*First Two Weeks.*—The earliest human ova with which we are acquainted were enumerated in the preceding chapter. With the exception of the one described by Bryce and Teacher, these were vesicular structures whose most prominent feature was the chorion, to one side of which was attached the future embryo, so small a body that its component parts could distinguished only with the aid of the microscope. In each of these ova



Fig. 159.

Fig. 160.

Fig. 161.

Fig. 162.

Fig. 163.

Fig. 164.

FIGS. 159-164.—EARLY EMBRYOS DESCRIBED BY HIS.

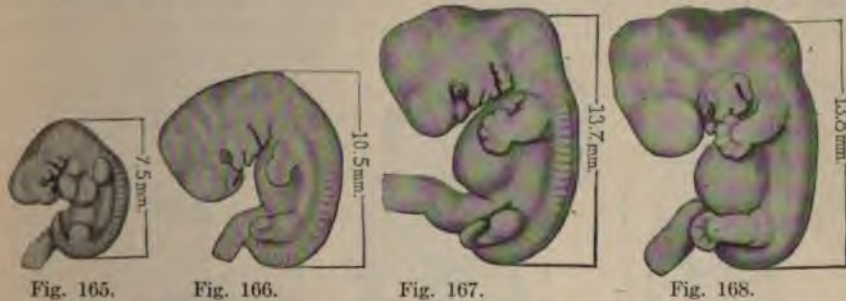
the embryonic area was covered by a well-developed amnion, and the great bulk of the structure consisted of the yolk-sac. Spee's ovum presented the earliest stages in the formation of the embryo itself—namely, the primitive streak. Figs. 159 to 164 represent early ova described by His.

*Third Week.*—The embryonal period begins with the third week, in the early part of which can be detected the beginning formation of the medullary groove and canal, soon to be followed by the appearance of the

head-folds. At this stage of development the abdominal pedicle is seen coming off from the tail end of the embryo, and lying almost in the same axis with it. The embryo is concave on its dorsal surface, and is made up in great part of the yolk-sac.

A little later the formation of the double heart may be noted; while in the latter part of the week the cerebral and optic vesicles appear, as well as the visceral arches and clefts. The yolk-sac becomes more and more constricted, and is connected with the ventral surface of the embryo by a broad pedicle. At the very end of the third week (about the twenty-first day) the limbs make their appearance as small buds upon the surface of the embryo.

*Fourth Week.*—This week is characterized by a great increase in the size of the embryo, which becomes markedly flexed upon its ventral surface, so that its head and tail ends come almost in contact. The rudiments of



FIGS. 165-168.—EMBRYOS FROM FOURTH AND FIFTH WEEKS (His).  $\times 2$ .

the eyes, ears, and nose now make their appearance, and the umbilical vesicle becomes still more pedunculated. At the end of the first lunar month the embryo measures from 7.5 to 10 millimeters (0.3 to 0.4 inch) in length.

*Second Month.*—In the first half of the second month the human embryo does not differ essentially in appearance from that of other animals. It is still markedly bent on itself, and the visceral clefts and arches are the most prominent characteristics of its cephalic region, while the extremities are in a very rudimentary condition. In the latter part of the month, owing to the development of the brain, the head becomes considerably larger, and assumes a certain resemblance to that of a human being. At the same time the nose, mouth, and ears become less prominent and the extremities more developed, so that it can be seen that they are made up of three portions. The external genitalia also make their appearance in the latter part of this month, and at its end the fœtus has attained a length of 2.5 centimeters (1 inch).

*Third Month.*—At the end of this month the entire product of conception is about as large as a goose's egg, and the embryo measures from 7 to 9 centimeters in length. Centers of ossification have appeared in most of the bones; the fingers and toes become differentiated and are supplied with nails; the external genitalia are beginning to show definite signs of sex.

*Fourth Month.*—By the end of the fourth month the fœtus is from 10 to 17 centimeters long, and weighs about 120 grams. An examination of the external genital organs will now definitely reveal the sex.

*Fifth Month.*—The fœtus varies from 18 to 27 centimeters in length, and weighs about 280 grams. Its skin has become less transparent, a downy covering is seen over its entire body, while a certain amount of typical hair has made its appearance on the head.

*Sixth Month.*—At the end of the sixth month the fœtus varies from 28 to 34 centimeters in length, and weighs about 634 grams. The skin presents a markedly wrinkled appearance, and fat begins to be deposited beneath it; the head is still comparatively quite large. A fœtus born at this period will attempt to breathe and move its limbs, but always perishes within a short time.

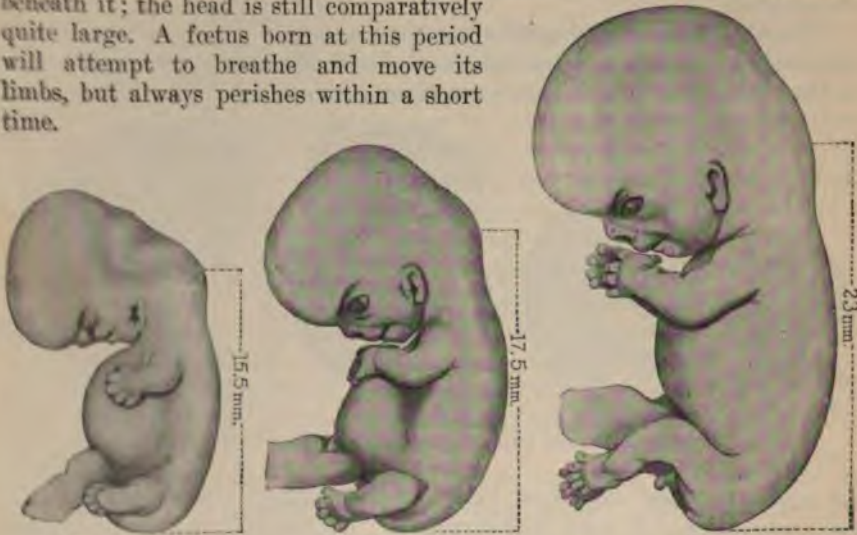


Fig. 169.

Fig. 170.

Fig. 171.

FIGS. 169-171.—EMBRYOS FROM SECOND MONTH (His).  $\times 2$ .

*Seventh Month.*—The length during this month varies from 35 to 38 centimeters, and the fœtus attains a weight of over 1,200 grams. The entire body is very thin, the skin is reddish and covered with vernix caseosa. The pupillary membrane has just disappeared from the eyes. A fœtus born at this period moves its limbs quite energetically and cries with a weak voice; but, as a rule, it cannot be raised, even with the most expert care, although an occasional successful case is found in the records.

It is generally believed among the laity that a child born at the end of the seventh month has a better chance of living than when it comes into the world four weeks later. This idea is a remnant of the old Hippocratic doctrine and is absolutely erroneous, as the more developed the child the greater are its chances for life.

*Eighth Month.*—At the end of the eighth month the fœtus has attained a length of 42.5 centimeters, and a weight of about 1,900 grams. The surface of the skin is still red and wrinkled and the child resembles an old man in appearance. Children born at this period may live if properly cared for, though their chances are not very promising.



## THE FŒTUS IN THE VARIOUS MONTHS OF PREGNANCY 149

*Ninth Month.*—At the end of the ninth month the fœtus is 46.75 centimeters long, and weighs about 2,500 grams. Owing to the presence of considerable fat, the body has become more rotund and the face has lost its previous wrinkled appearance. Children born at this time have a very fair chance of life if properly cared for.

*Tenth Month.*—Full term is reached at the end of this month. The fœtus is now fully developed, and presents the appearances which we shall consider in detail when we describe the new-born child.

The fœtus grows relatively much faster in the early than in the later months of pregnancy. According to Jackson, the weight of the mature ovum is only 0.000004 gram, which increases to 0.04 gram by the end of the first month after fertilization—an increase of 9,999 times, or practically one million per cent. In the second and third months the rate of increase has become reduced to 74 and 11 times respectively, and gradually falls to 0.45 time in the last month. Even this comparatively slow rate is not maintained after birth, for if it were the child would weigh 250 kilograms by the time it was one year old.

According to Zangemeister, the average length and weight of the fœtus in the various lunar months are as follows:

| MONTH.     | LENGTH.         | WEIGHT.     |
|------------|-----------------|-------------|
| 1st .....  | 0.7 centimeter  | 1.0 gram    |
| 2nd .....  | 2.5 centimeters | 2.5 grams   |
| 3rd .....  | 9    “          | 12.4   “    |
| 4th .....  | 13.4   “        | 89.8   “    |
| 5th .....  | 18.9   “        | 252.7   “   |
| 6th .....  | 31.6   “        | 795.5   “   |
| 7th .....  | 34.5   “        | 1,066.0   “ |
| 8th .....  | 39.3   “        | 1,540.1   “ |
| 9th .....  | 45.5   “        | 2,243.3   “ |
| 10th ..... | 49.93   “       | 3,242.4   “ |

These figures possess only an approximate value, and generally speaking the length affords a more accurate criterion of the age of a child than its weight. Haase has suggested that the length of the embryo in centimeters may be roughly approximated during the first five months by squaring the number of the month to which the pregnancy has advanced; in the second half of pregnancy, by multiplying the month by 5, as is shown in the following table:

|                                    |       |                |
|------------------------------------|-------|----------------|
| At the end of the first month..... | 1×1,  | 1 centimeter.  |
| “   “   “ second month .....       | 2×2,  | 4 centimeters. |
| “   “   “ third month .....        | 3×3,  | 9   “          |
| “   “   “ fourth month .....       | 4×4,  | 16   “         |
| “   “   “ fifth month .....        | 5×5,  | 25   “         |
| “   “   “ sixth month .....        | 6×5,  | 30   “         |
| “   “   “ seventh month .....      | 7×5,  | 35   “         |
| “   “   “ eighth month .....       | 8×5,  | 40   “         |
| “   “   “ ninth month .....        | 9×5,  | 45   “         |
| “   “   “ tenth month .....        | 10×5, | 50   “         |

*The Child at Full Term.*—The average child at full term is 50 to 51 centimeters (20 to 21 inches) long, and weighs 3,250 grams ( $7\frac{1}{4}$  pounds). The skin is smooth and polished in appearance, and shows no lanugo, except occasionally about the shoulders. Over the entire surface is spread a whitish, greasy material, the *vernix caseosa*, which is a mixture of epithelial cells, lanugo hairs, and the secretion of the sebaceous glands. The head is usually covered by darkish hairs 2 to 3 centimeters in length, and the cartilages of the nose and ears are well developed. The fingers and toes possess well-developed nails, which project beyond their tips. In male children the testicles are usually found within the scrotum; in girls the labia majora are well developed and are in contact with one another, and usually conceal the rest of the genitalia. The bones of the head are well ossified, and are in close contact at the various sutures.

At autopsy a center of ossification, 0.5 centimeter in diameter, is found in the lower epiphysis of the femur. This was first described by Blécard, in 1826, as a diagnostic sign of maturity. It is not infallible, however, as Hartmann has shown that it was absent in 12 out of 102 full-term children which he examined. Hahn, after studying a large number of premature and mature children by means of Röntgen rays, states that the center of ossification at the proximal epiphysis of the tibia is always lacking in the former and present in the latter class; while Holzbach, on the other hand, holds that the most valuable sign of maturity is to be found in the relation between the fronto-occipital circumference of the head and that of the shoulder, as in only 1 out of the 31 premature children which he examined did the latter equal the former in size. No one of these conditions affords indisputable proof of the maturity of a child, but when the majority of them are present the evidence becomes fairly convincing.

Negro babies at birth differ somewhat in appearance from white children, but not so markedly as one would expect. Their skin presents a dusky, bluish-red hue, but does not at all suggest the darker color which it will assume in the course of a few weeks. Where there is a considerable admixture of white blood, the dusky hue may be entirely absent, and the only evidence of negro ancestry will be found in an increased pigmentation about the external genitalia.

**Weight of the New-born.**—The average infant at birth weighs about 3,250 grams ( $7\frac{1}{4}$  pounds), boys being usually 100 grams (3 ounces) heavier than girls. Marked variations are frequently observed, which are dependent upon the race and size of the parents, the number of children which the mother has borne, her mode of life, and her nutrition and general condition during the later months of pregnancy. In 707 full-term white children born at the Johns Hopkins Hospital, T. F. Riggs found that the average length was 49.64 centimeters, and the average weight 3,316.9 grams (7.54 pounds), the smallest child weighing 2,180 grams (4 pounds 11 ounces) and the largest 4,553 grams (9 pounds 12 ounces).

It appears that colored children weigh considerably less than white, a fact which, in large cities, at least, is indicative of the physical degenera-

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tion which characterizes the race. Four hundred and seventy full-term colored children measured by Riggs averaged 48.75 centimeters in length and 3,104.8 grams in weight, a difference of 211 grams (7.2 ounces) in favor of the white race.

Similar but less marked differences may be observed in the different countries and even in various portions of the same country. Thus, Schroeder found that the children born in Bonn averaged 71 grams ( $2\frac{1}{2}$  ounces) less in weight than those observed by Hecker in Munich.

Perfectly healthy full-term children may vary from 2,300 to 5,000 grams (5 to  $10\frac{3}{4}$  pounds) in weight. They rarely exceed the latter figure, although it is not unusual to hear of children weighing 15, 16, and even 20 pounds at birth. The majority of such cases, however, must be regarded as apocryphal, and careful inquiry will usually show that the weight has been only roughly estimated by lifting the child in the hand, and not based upon accurate determination. Winckel found only 5 children that weighed over 5,000 grams in 30,500 deliveries, and Starcke 16 in 34,000 deliveries in Leopold's clinic. According to Ludwig, out of 15,166 children born in Chrobak's clinic in Vienna, only 1 weighed 5,300 grams ( $11\frac{1}{8}$  pounds), and Varnier states that in seven years, at the Baudelocque Clinic in Paris, there were only 6 children that exceeded 5,000 grams at birth, the largest weighing 6,150 grams (13 pounds 3 ounces). Moreover, it is probable in many instances, as pointed out by Winckel, that the excessive weight of such children should be attributed to the fact that pregnancy has lasted some weeks longer than usual.

In over 12,000 children delivered under my supervision, the largest weighed 5,833 grams, or 12 pounds 8 ounces; though several of my friends have met with babies which were considerably heavier. Dubois, in 1897, collected from the literature 28 cases in which the child weighed 5,600 grams (12 pounds) or more at birth, and stated that the heaviest children on record were reported by Ortega, Rachel and Neumer, and Beech, and weighed respectively 11,300 (24 pounds 3 ounces), 11,250 (24 pounds 2 ounces), and 10,750 grams (23 pounds 12 ounces). Ortega's child was 70 centimeters (28 inches) long, and Beech's 76 centimeters (30 inches). Ludwig, in 1896, reported a case in which he was obliged to perform Cæsarean section, after craniotomy and amputation of the extremities, in order to deliver a child weighing 7,700 grams (16 pounds 8 ounces). But in spite of these exceptional cases, one should be extremely skeptical in accepting reports concerning phenomenally heavy children, unless one is convinced that the reporter is a truthful person and has weighed the child upon an accurate balance.

On the other hand, healthy full-term children frequently weigh less than 3,250 grams (7 pounds) in weight, and sometimes as little as 2,333 grams (5 pounds). Any weight below this limit, in the case of an infant born at term, should always lead one to suspect some disease on the part of the mother or foetus, as nephritis or syphilis.

Generally speaking, premature children weighing less than 1,500 grams (3 pounds 3 ounces) have practically no chance of life, though in exceptional cases they have done well. Piering reports raising a premature



•. child that weighed only 1,120 grams at birth, and mentions cases under the charge of Ritter, Rodman, and D'Outrepont in which children weighing only 717, 719, and 750 grams respectively were successfully reared. Dr. H. A. Powell, of Cleveland, informs me that he has successfully raised an infant which weighed only 750 grams at birth.

The size of the fœtus increases with the age of the mother up to the twenty-eighth or thirtieth year, if pregnancies have not followed in too rapid succession; the children of succeeding pregnancies usually follow the same rule. The size is also dependent, to a considerable extent, upon that of the parents, especially the father; and in many instances its head closely resembles that of the father in shape.

The social condition of the mother and the comforts by which she is surrounded also exert a marked influence upon the child's weight, heavier children being more common in the upper walks of life. Thus, on looking over the records of my private cases, which are almost exclusively among the well-to-do classes, I found that healthy full-term children, weighed upon the same pair of scales, averaged 3,795 grams (8 pounds 2 ounces) in weight, as compared with 3,316.9 and 3,104.8 grams for the white and colored children in hospital practice—a difference of 478 and 690 grams, respectively.

Pinard and Bachimont, from a study of 4,445 cases observed in the Baudelocque Clinic, arrived at more or less similar conclusions. They found that the children of women who had lived in the hospital for three months prior to confinement averaged 500 grams (1 pound 2 ounces) heavier than those of patients who had entered the hospital just before or during labor. They consider that this difference is due to the better nourishment of the former class of patients, as well as to the absence of premature labor incident to hard work. T. F. Riggs, upon analyzing my cases at the Johns Hopkins Hospital, arrived at similar conclusions, but found that there was a greater increase in weight in the colored than in the white children. He was inclined to attribute the difference to the fact that the hospital fare was not much better than that which the white women received in their own homes, but was far superior to that to which the average colored woman is accustomed.

It is generally believed that the comparatively difficult labors of the women of the upper classes are due to the enervating influences of civilization and luxury, while the easy labors of the colored women are considered as manifestations of a closer approach to Nature. These conclusions are not justified by my experience, as I believe that the colored women seen in large cities are physical degenerates, in whom contracted pelvis occur four or five times more frequently than in white women. Were this not counterbalanced by the lesser weight of their children, and particularly by the smaller size and greater compressibility of their heads, labor would be a most disastrous function, and would comparatively soon lead to a solution of the race problem. I am inclined to believe, if their children were as large and had as hard heads as in the upper classes, that I should be obliged to perform a Cæsarean section a week, instead of a small number a year, as at present. Accordingly, it appears permis-

sible to attribute the more difficult labors of the upper classes to the larger size of their children, resulting from abundant nutrition and a life of ease, rather than to the enervating influences of civilization.

Provided the pelvis is normal, it is unusual for children weighing less than 5,000 grams (10 pounds) to cause difficult labor simply from their size, since Varnier has shown that the diameters of the head do not increase in the same ratio as the weight of the child.

**The Head of the Child.**—From an obstetrical point of view the head of the child is its most important part, as the essential feature of labor

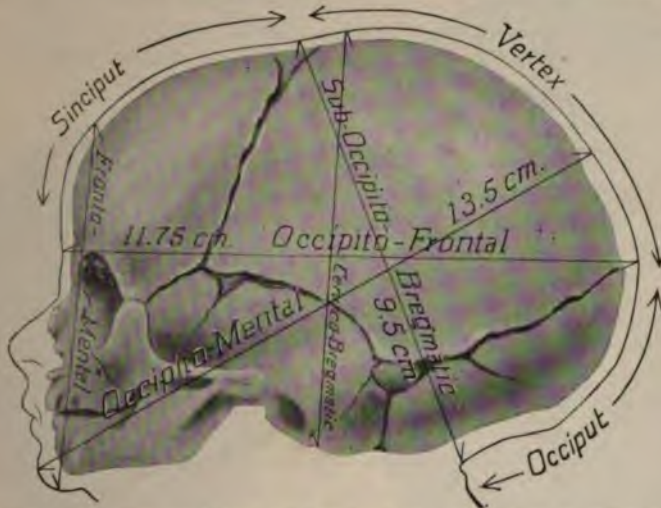


FIG. 172.—CHILD'S HEAD AT TERM.  $\times \frac{2}{3}$ . (American Text-Book.)

is a process of adaptation between it and the various portions of the pelvis through which it passes. An accurate knowledge of its characteristics and size is therefore of capital importance.

Only a comparatively small part of the head of the child at term is represented by the face, the rest being composed of the firm, hard skull, which is made up of two frontal, two parietal, two temporal bones, the upper portion of the occipital, and the wings of the sphenoid. These bony portions are not firmly united together, but are separated from one another by spaces filled with membrane—the *sutures*. Of these the most important are the *frontal*, between the two frontal bones; the *sagittal*, between the two parietal bones; the *coronal*, between the frontal and parietal bones; and the *lambdoid* suture, between the posterior margins of the parietal bones and the upper margin of the occipital bone. All of these sutures can be felt during labor; whereas the *temporal* suture, which is situated on either side between the inferior margin of the parietal and the upper margin of the temporal bones, is covered by soft parts and cannot be felt on the living child.

Where several sutures meet together an irregular space is formed, which is closed by a membrane and designated as a *fontanelle*. We usu-

ally distinguish four such structures: the greater and lesser, and the two temporal fontanelles. The *greater* or *anterior fontanelle* is a lozenge-shaped space situated at the junction of the sagittal and the coronal sutures. The *lesser* or *posterior fontanelle* is represented by a small triangular area at the intersection of the sagittal and lambdoid sutures. These are readily felt during labor, and their recognition gives important information concerning the position and presentation of the child.

The *temporal* or *Gasserian fontanelles*, which are situated at the junction of the lambdoid and temporal sutures, cannot be felt on vaginal examination.

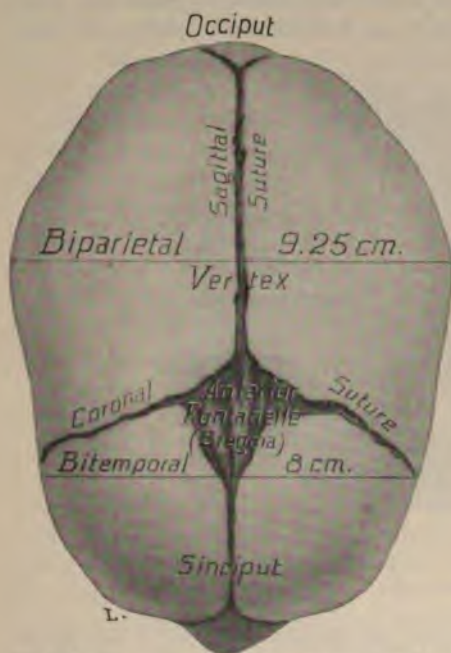


FIG. 173.—CHILD'S HEAD AT TERM.  $\times \frac{2}{3}$ .  
(American Text-Book.)



FIG. 174.—HEAD AT TERM, SHOWING SMALL, SAGITTAL, AND LARGE FONTANELLES.  $\times \frac{1}{2}$ .

Arnold Lea directed attention to the occasional presence of what he designates as the *sagittal fontanelle*, which is a lozenge-shaped space found in the sagittal suture at a point about half-way between the greater and lesser fontanelles. He considers that it results from faulty ossification of the parietal bones, and states that it occurs quite frequently—in 22 out of 500 foetal skulls which he examined (4.4 per cent.). I have met with a similar structure in only a few instances, and in several it gave rise to a serious error in diagnosis. Since that time I have examined several hundred foetal heads just after birth, but have not encountered the abnormality frequently, so that it would seem probable that Lea's experience was exceptional.

To aid us in forming definite ideas concerning the shape and size of the foetal head, it is customary to measure certain *diameters* and *circumferences*. The diameters most frequently used are: (1) the fronto-occipital, which follows a line extending from the root of the nose to the most



prominent portion of the occipital bone; (2) the biparietal, which represents the greatest transverse diameter of the head, and usually extends from one parietal boss to the other; (3) the bitemporal, which represents the greatest distance between the two temporal sutures; (4) the mento-occipital, from the chin to the most prominent portion of the occiput; and (5) the suboccipito-bregmatic, which follows a line drawn from the middle of the large fontanelle to the under surface of the occipital bone, just where it joins the neck. For convenience the various diameters are frequently designated by initials, which, with their several average measurements, are given in the following table:

|                                     | Centimeters. | Races. |        |
|-------------------------------------|--------------|--------|--------|
|                                     |              | White. | Black. |
| Fronto-occipital, F. O.....         | 11.75        | 11.71  | 11.26  |
| Biparietal, B. P.....               | 9.25         | 9.25   | 9.05   |
| Bitemporal, B. T.....               | 8            | 8      | 7.81   |
| Mento-occipital, M. O.....          | 13.5         | 13.33  | 13.31  |
| Suboccipito-bregmatic, S. O. B..... | 9.5          | 9.70   | 9.29   |

The greatest *circumference of the head*, which corresponds to the plane of the fronto-occipital diameter, is 34.5 centimeters, while the least circumference, corresponding to the plane of the suboccipito-bregmatic diameter, is 32 centimeters. The figures just given are based upon the average measurements of a large number of heads just after birth, individual variations being frequently encountered. As a rule, boys have somewhat larger heads than girls, and the children of multiparæ than those of primiparæ. As indicated in the table, Riggs's figures show that all of the diameters are shorter in negro children; but such measurements give no idea of the greater softness and compressibility of the head.

A certain amount of motility exists at the sutures between the various bones composing the skull. This may vary within relatively wide limits in different individuals, so that heads which afford the same diameters on actual measurement not infrequently differ markedly in the obstacle which they offer to labor, as the bones of one may be soft, compressible, and readily displaced, while those of another are firmly and densely ossified and admitting of but little motility, the former being readily molded to the genital canal, while the latter are incapable of reduction in size.

**Physiology of the Fœtus.**—Our knowledge concerning the physiology of the fœtus has been markedly enriched during recent years; nevertheless, when compared with that of the adult, it offers many points concerning which we are but slightly informed or profoundly ignorant.

*Nutrition of the Fœtus.*—Owing to the small amount of yolk contained in the human ovum, the growth of the fœtus is almost entirely dependent upon the amount of nutritive material which it obtains from its mother.

During the first few months of pregnancy, as Fehling first pointed out, the embryo consists almost entirely of water, and it is during this period that it grows most rapidly. In the later months of pregnancy, when more

solids are being added, the increase in size becomes gradually slower. Fehling's conclusions were confirmed by Michel, who analyzed fœtuses at various periods of development with the following results:

|                    | Water.          | Albuminoids.   | Salts.          | Fats.           |
|--------------------|-----------------|----------------|-----------------|-----------------|
| At 2½ months...    | 93.82 per cent. | 4.39 per cent. | Trace.          | Trace.          |
| 3d to 4th month... | 89.95 "         | 7.05 "         | 1.729 per cent. | .0379 per cent. |
| 7th month.....     | 84.75 "         | 10.04 "        | 2.487 "         | 1.823 "         |
| At term.....       | 69.16 "         | 13.96 "        | 3.373 "         | 11.75 "         |

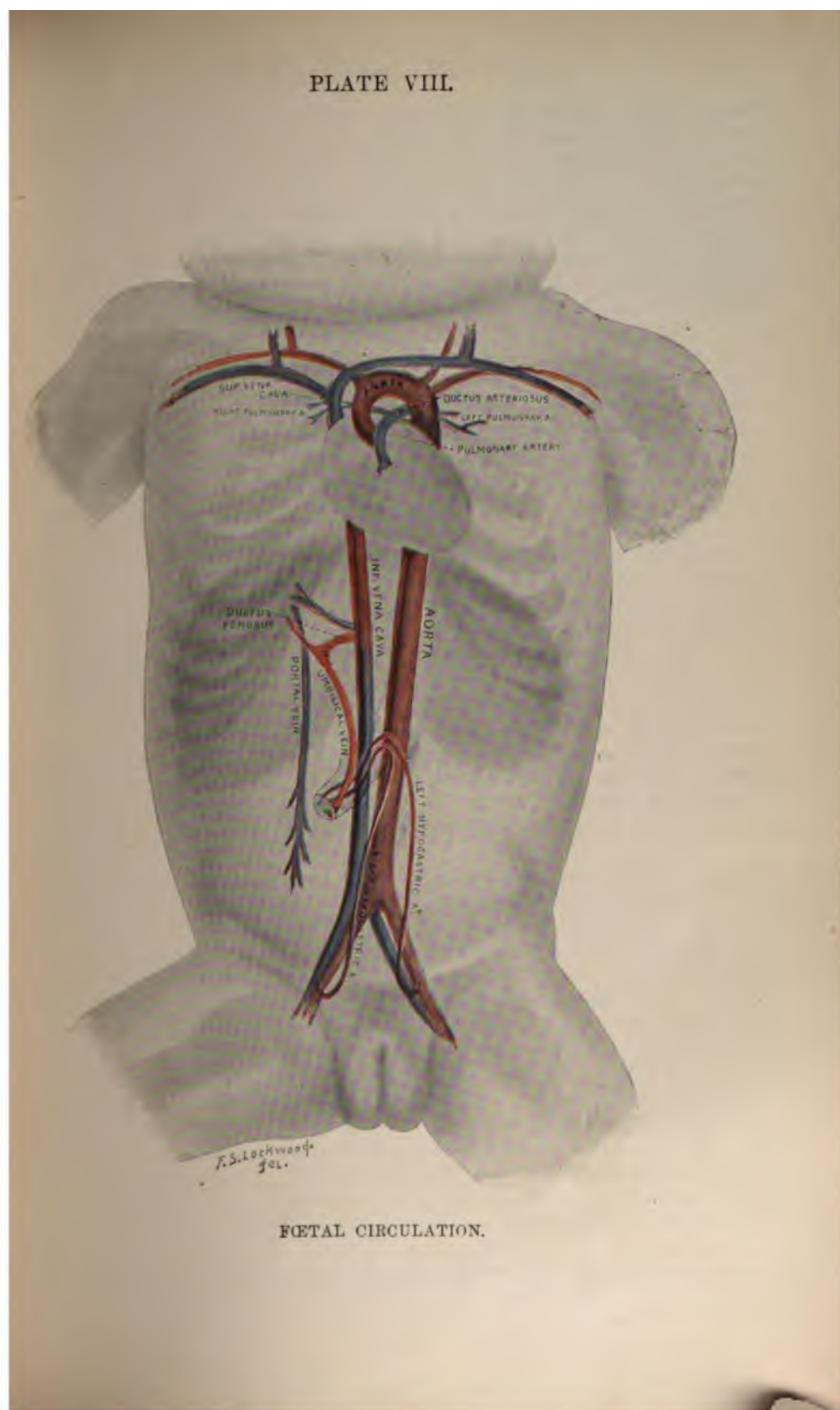
It is therefore apparent that, as the fœtus increases in age, it contains relatively less water and a markedly increased quantity of albuminoid materials, salts, and fats.

For the first few days after the implantation of the ovum upon the decidua, its nutrition is derived from the serum which accompanies the œdematous condition of the latter, from the surrounding maternal tissue which has undergone necrosis as the result of the digestive action of the trophoblast, and probably from the glycogen, which Driessen has shown accumulates in the glandular epithelium and the stroma of the endometrium during the period of premenstrual swelling. Within the next week intervillous spaces, which are filled with maternal blood, begin to develop between the trophoblast and decidua. As the chorionic villi at this period are devoid of vessels, the only way in which nutritive material can be taken up from the maternal blood, by which they are surrounded, is by osmosis.

In the third week of pregnancy the omphalo-mesenteric vessels make their appearance upon the surface of the umbilical vesicle, and whatever nutritive materials the latter may contain are conveyed to the embryo by them. During the fourth week branches of the umbilical vessels appear in the chorionic villi, and from this time on make possible the direct transmission of nutritive material from the maternal to the fœtal blood.

*The Fœtal Circulation.*—Owing to the fact that the materials needed for the nutrition of the fœtus are brought to it by the umbilical vein, the fœtal circulation differs materially from that of the adult (Plate VIII). The blood is purified and laden with nutritive material in the placenta, and is then carried to the fœtus through the umbilical vein, which, after penetrating the abdominal wall, divides into two branches. Of these the smaller unites with the portal vein, the blood from which circulates through the liver and then gains access to the inferior vena cava through the hepatic vein. The other, the larger branch, which is designated as the ductus venosus, empties directly into the vena cava. The contents of the vena cava above the hepatic vein, therefore, consist of a mixture of arterial blood from the placenta and venous blood returning from the lower extremities of the fœtus. Thus far all investigators agree, but there is still considerable divergence of opinion as to the course the blood takes after leaving the vena cava. It is generally taught that upon entering the right auricle it is deflected by the intervention of the

PLATE VIII.



FETAL CIRCULATION.





Eustachian valve in such a manner as to pass through the foramen ovale into the left auricle, whence it passes into the left ventricle, which forces it into the aorta. On the other hand, the blood returning from the head and upper extremities by way of the superior vena cava is poured into the right auricle, and, crossing the current from the inferior vena cava, passes into the right ventricle, whence it is forced into the pulmonary arteries. But so long as the lungs do not function, only a small portion of this blood gains access to them, the greater part of it passing through the ductus arteriosus to the arch of the aorta, and being then carried to the rest of the body of the embryo.

According to this view, the blood from the inferior and superior vena cava does not mix in the right auricle, but the two currents cross one another in such a way that the purer blood from the inferior cava passes directly to the left side of the heart through the foramen ovale, and is supplied in great part to the head and neck; while the less pure blood from the superior cava passes through the right auriculo-ventricular opening and is forced by the right ventricle into the pulmonary arteries and the ductus arteriosus.

Pohlman (1909) states that this view is incorrect, and that the two currents mix in the right auricle, while enough of the mixed blood passes into the left auricle through the foramen ovale to make up for the deficient return through the pulmonary veins. Ziegenspeck likewise believes that the blood in the two auricles is identical in composition, but is accomplished in a different manner.

In any event, the blood which has gained access to the aorta directly from the left and also from the right ventricle, through the ductus arteriosus, is propelled down the aorta and given off to the various organs according to their needs; but the bulk of it enters the internal iliac and hypogastric arteries—the latter after passing the umbilicus being designated as the umbilical arteries—and through them gains access to the placenta.

From the foregoing description it is apparent that the blood circulating in the fœtus is at no time strictly arterial or strictly venous, but that the content of the inferior vena cava is purer than that of the aorta.

The distinctive features of the fœtal circulation are connected with the ductus venosus and arteriosus, the foramen ovale, the hypogastric arteries, and the umbilical cord. After birth these structures undergo marked changes. As soon as the child is born and begins to breathe, the pulmonary circulation becomes established. As a result, a much greater quantity of blood is pumped by the right ventricle into the pulmonary arteries, while a lessened amount passes through the ductus arteriosus. Moreover, as soon as the circulation in the cord is abolished, the umbilical vein becomes functionless, and a diminished quantity of blood is returned to the right auricle by the inferior vena cava. This change leads to a diminution in the tension in the right auricle, while that in the left side of the heart is increased, bringing about the closure of the valve-like foramen ovale.

As the circulation through the umbilical arteries ceases almost imme-

diately after the pulmonary circulation is established, the function of the hypogastric arteries is rendered useless, and their distal ends rapidly undergo atrophy and obliteration, which is usually complete three or four days after birth. The ductus venosus and umbilical vein also become occluded during the first week, whereas the closure of the ductus arteriosus is more gradual, and frequently its opening does not become impervious until several weeks after birth. Permanent closure of the foramen ovale does not occur for some time, and not rarely months elapse before it is completed. Occasionally it remains more or less patent, and circulatory disturbances of greater or less gravity result from its persistence.

*Transmission of Substances through the Placenta.*—As was shown when considering the structure of the placenta, there is no direct communication between the vessels of the chorionic villi and the intervillous blood spaces. In the first half of pregnancy foetal and maternal blood are separated from one another by the syncytium, Langhans's layer of cells, a thicker or thinner leaflet of the stroma of the villus, and the walls of the foetal capillaries, while in the second half Langhans's layer gradually disappears.

The independence of the two circulations is readily demonstrated on examining the contents of the foetal vessels and the intervillous spaces. In the former large numbers of nucleated red corpuscles are found, which are never present in the latter. In order that substances may pass from the mother to the foetus, or in the reverse direction, it is necessary for them to traverse the layers of tissue which we have just mentioned. It would appear that gases and substances in solution pass by osmosis directly from the maternal blood to the vessels of the chorionic villi, and *vice versa*, but that colloids and formed substances must undergo certain changes in the chorionic epithelium before they can be transmitted.

The transmission of gaseous substances has been definitely demonstrated both by clinical observation and experimental work. Comparison of the blood in the umbilical vein and arteries, respectively, shows that the former is lighter in color, indicating that it is richer in oxygen than the latter. This fact has also been demonstrated experimentally by Zweifel, who showed that the blood in the umbilical vein, when examined by means of the spectroscope, contained oxyhæmoglobin. Again, Cohnstein and Zuntz have demonstrated that the blood of the umbilical vein in the sheep is richer in oxygen and poorer in carbon dioxide than that contained in the umbilical arteries. Zweifel has also shown that chloroform administered to the mother is rapidly transmitted to the foetus, and Nicloux has made similar observations with ether.

The increase in the size of the foetus affords conclusive evidence that materials in solution must pass from the maternal to the foetal circulation, and this has been demonstrated experimentally for many substances. The first work of this character we owe to Mayer, who in 1817 proved the passage of cyanide of potassium. Since then conclusive evidence has been adduced of the transmission of many inorganic and organic salts, alcohol and other compounds. Nicloux summarized our knowledge upon the subject up to 1909, and among other substances mentioned iodid and bro-



mid of potassium, phosphorus, the salts of mercury, copper, arsenic, and lead, carbolic acid, salicylate of sodium, quinin, morphia, atropin, and urea.

Krönig and Fütth in 1901 investigated the molecular concentration of the foetal and maternal blood by determining their freezing points. They found that both fluids froze at the same temperature, a fact which indicates that they possess the same osmotic pressure, and consequently osmosis can occur equally readily in either direction.

The evidence concerning the passage of formed substances through the placenta is conflicting, but it is now generally believed that such does not occur, unless the material has first undergone marked changes under the influence of the chorionic epithelium, or when the placenta presents lesions. The work of Bonnet, Hofbauer, Wallgren, Ascoli, and others clearly shows the various substances, such as iron, fat, and albuminous substances, are taken up by the syncytium, and after undergoing radical changes are eventually passed on to the foetal circulation. Our knowledge upon the subject up to 1909 was well summarized by Hofbauer. Iron is taken up by the trophoblast in the form of hæmoglobin derived from hæmolyzed maternal blood, and by appropriate biochemical methods can be demonstrated in the epithelium and stroma of the villi on its way to the foetal vessels.

Fat is not absorbed as such, but is broken down in the outer portion of the syncytium into its constituents, which are later recombined just as in the intestines. This was shown conclusively by Hofbauer, who, after feeding pregnant animals with fat stained with Sudan red, found the characteristically stained fat in the intervillous spaces, but only unstained fat was demonstrable in the syncytium and stroma of the villi, while the pigment was found in the foetal blood.

Albuminous substances are not absorbed as such, but are likewise broken down into simpler compounds, which are recombined after passing through the chorionic epithelium. It is, however, doubtful whether they are resolved into their constituent amino-acids, as Ascoli, Hofbauer and others were unable to isolate such substances, and could only demonstrate the presence of albumoses.

Although Claude Bernard,\* as early as 1859, demonstrated the presence of glycogen in the placenta, its significance has only recently been appreciated. The investigations of Driessen, Jaretsky, and others have shown that before each menstrual period it is deposited in considerable quantities in the endometrium apparently in anticipation of the nutrition of the ovum. Moreover, in the first half of pregnancy, large quantities of glycogen are found not only in the decidua but also in the syncytium, cell nodes, and trophoblastic islands of the placenta, so that these structures in all probability store glycogen and give it up to the foetus whenever sugar is needed.

Accordingly, it appears that the passage of organic substances through the placenta is accomplished by processes analogous to those occurring in the intestines, and that the syncytium is not only able to change many substances, but also has definite powers of selection. Plausibility is lent

to such a view by the discovery by Bergell and Falk, Liepmann, Lockhead, and others of the presence of various ferments in the chorionic villi, more particularly in the syncytium. Proteolytic, lipolytic, glycolytic, and various oxidizing ferments have been described; while the discovery by Savaré of a desamidizing ferment, by which the amino group of the amino-acids is converted into ammonia, gives us a clew as to the mechanism by which the waste products of the fœtus are disposed of.

The work of Polano, Wegelius, and others has shown that many toxins and antitoxins are transmitted through the placenta—notably those of diphtheria, tetanus, colon and typhoid. Furthermore, Wegelius has proved that such transmission is not mere filtration or osmosis, but is due to some selective action on the part of the syncytium; as, after inducing active or passive immunity in the mother, he was able to demonstrate in certain cases that the antibody titer was higher in the foetal than in the maternal serum.

The question as to whether the placenta acts as an efficient filter against bacteria has given rise to a great deal of discussion, but at present the consensus of opinion is that such transmission occurs but rarely, and usually only in connection with some distinct lesion of the organ. The occurrence of intra-uterine smallpox was urged by John Hunter and many subsequent observers as proof in support of the affirmative view. Formerly it was not infrequent for mothers who suffered from smallpox during pregnancy to give birth to children bearing marks of the disease, and one of the most celebrated cases of this character was that of Mauriceau, the well-known obstetrician of the seventeenth century, who was born pock-marked. The significance of this occurrence, however, is by no means clear, inasmuch as we are not as yet acquainted with the *materies morbi* concerned.

Lubarsch has shown that the organisms of anthrax, pneumonia, typhoid fever, relapsing fever, and the various infections due to pyogenic organisms may be transmitted now and again, but regards such an occurrence as exceptional. This is particularly well shown in tuberculosis, but out of the large number of tuberculous women who are delivered every year, Hauser in 1898 was able to collect only 18 who had given birth to children or placenta which gave evidence of the disease. But in none of the placenta from tuberculous women which I have examined have I been able to find the slightest trace of tuberculosis in the foetal portion, even when the decidua was affected by the disease.

The same applies to typhoid fever, though it would appear that in this disease the transmission of organisms occurs quite frequently. Speier, in 1897, found the specific bacilli in the organs of a fœtus whose mother was suffering with typhoid fever, and collected 11 similar cases from the literature. F. W. Lynch, in 1902, reported a case of the same character which was observed in my service, and since then we have repeatedly made similar observations. Hicks and French noted such a transmission in 10 out of 30 cases, and it is now generally recognized as a frequent concomitant of the disease.

In other affections it would appear that transmission never occurs from



mother to fœtus. Thus, in malaria there is no evidence that the specific parasites can pass from the maternal to the fœtal blood.

The transmission of materials from the fœtus to the mother has also been experimentally demonstrated for animals. Thus Savory and Guserow showed, by injecting strychnin into embryos still within the uterus, that the mother died within a short time from strychnin poisoning. Similar results were also obtained by Preyer with hydrocyanic acid, and by Nicloux with alcohol.

*The Nature and Functions of the Amniotic Fluid.*—In addition to the materials received from the placenta, it is generally believed that the fœtus obtains a great part of the fluid necessary for its development from that contained in the amniotic sac. Spiegelberg, Ahlfeld, Zweifel, and others have demonstrated that considerable quantities of it are swallowed, inasmuch as they found lanugo hairs, epidermic cells, etc., in the stomach and intestines of the fœtus. Ahlfeld believes that the amniotic fluid is swallowed in such large quantities that even the small amount of albumin which it contains aids in the nutrition of the fœtus; but this point is very doubtful. Besides this function, the amniotic fluid plays an important part by surrounding the fœtus with a medium of constant temperature, which serves to prevent loss of heat while at the same time affording a protection against sudden shocks from without. It also subserves an important function by preventing the formation of adhesions between the fœtus and the walls of the amniotic sac, which, when they occur, often give rise to serious deformities to be considered later.

According to Hoppe-Seyler, the amniotic fluid is clear, alkaline in reaction, having a specific gravity of 1.006 to 1.008, and consisting of 98.48 per cent. water, 0.19 per cent. albuminoid material, 0.556 per cent. soluble inorganic salts, 0.8 per cent. extractives, and 0.024 per cent. insoluble organic salts.

Unfortunately it is impossible at this time to make perfectly positive statements concerning the origin of the amniotic fluid in women, and those interested in the subject will find our knowledge up to 1910 well summarized in the articles of Ahlfeld and Wolff. From time to time four main views have been advanced as to its origin: (1) fœtal urine; (2) transudation from maternal blood; (3) secretion through the amniotic epithelium, and (4) a mixed origin.

The first view was advocated in the seventeenth century by Portal, and has had many adherents until recently. Practically all investigators agree that the fœtal kidneys are capable of functioning in the later months of pregnancy, and undoubtedly do so under abnormal conditions, notably in certain cases of uniovular twin pregnancy. On the other hand, it is extremely doubtful whether they function at all under normal conditions, as it would appear improbable that the fœtus would swallow its own urine. Moreover, the fact that the amniotic fluid is present in very early ova, even before the development of the embryonic area, and at a somewhat later period before the development of the fœtal kidneys, clearly indicates that in early pregnancy at least some other origin must be sought. Furthermore, the occurrence of dropsical ova, in which all trace



of the fœtus has disappeared, while the amniotic sac is distended by fluid, forces us to a similar conclusion. Finally analysis of the amniotic fluid shows that it contains very small quantities of urea, and indicates, if it is fœtal urine, that it differs very markedly from that excreted during extra-uterine life.

The question has also been approached experimentally, particularly by Schaller. This observer availed himself of the well-known fact that the administration of phloridzin gives rise to a transitory diabetes, which results from the action of the drug upon the renal epithelium and not from changes produced in the blood. He showed that after the drug had been injected into the mother its presence could readily be demonstrated in the tissues of the fœtus, while the amniotic fluid rarely contained traces of sugar, which should have been present in large quantity had the fœtal kidneys functioned.

Until very recently many authorities believed that the amniotic fluid was in great part at least a transudation from the maternal vessels. Probability is lent to such a view by the fact that an excessive quantity of amniotic fluid is present in certain dropsical conditions of the mother, but more particularly by the results following the injection of certain substances into the maternal circulation. When potassium iodid or sodium indigo sulphate is so injected the substance promptly appears in the amniotic fluid, but no trace can be demonstrated in the fœtal kidneys. Furthermore, glucose is frequently present in the amniotic fluid of women suffering from diabetes, while it is uniformly absent in normal pregnancy.

On the other hand, the fact that Zangemeister and all subsequent investigators have found that the freezing point of the amniotic fluid is lower than that of the maternal serum clearly indicates that the former cannot be derived from the latter by filtration. Furthermore, the biochemical investigations of Polano show that the amniotic fluid does not contain certain antibodies found in the maternal serum, which should be present were the former a mere transudate; while the amniotic fluid and maternal serum lack a staphylolysin which is present in the fœtal urine. Consequently, he concluded, since the amniotic fluid was derived neither from the maternal serum nor from the fœtal urine, that the only origin possible must be a direct secretory action on the part of the amniotic epithelium.

Particularly in certain cases of hydramnios, histological examination by Polano, Bondi, Mandl, and others shows that certain changes occur in the amniotic epithelium which can only be interpreted as manifestations of secretory activity. Likewise, the investigations of Goldmann upon "vital staining" point to a similar conclusion. Upon injecting pregnant animals with pyrrhol-blue, this observer found that the body of the mother took on a blue stain, which did not pass over to the fœtus. At the same time, however, the amniotic fluid became blue, while the amniotic epithelium was deeply pigmented.

Finally, it should be borne in mind that a great part at least of the amniotic fluid may represent a transudation through the surface of

the foetus or through the vessels of the cord; and, furthermore, as shown by the experiments of Wolff, that the foetal kidneys may function if those of the mother become insufficient.

Accordingly, from the evidence at present available, it would appear that under normal conditions the amniotic fluid is derived primarily from the maternal serum, which is profoundly modified during its passage through the amniotic epithelium; but that under abnormal conditions other sources, more particularly the foetal urine, will have to be taken into consideration.

*Respiratory and Digestive Functions.*—It would appear that the foetus *in utero* requires a relatively small quantity of oxygen to support life, so there is but little tissue waste. Again, the fact that it is surrounded by amniotic fluid makes it necessary for the foetus to produce but little warmth, as only a small amount of energy is expended during its restricted movements. Its need of oxygen, however, is demonstrated by the rapid occurrence of death, with symptoms of asphyxia, whenever the circulation of the umbilical cord is interfered with even for a short time.

It has been demonstrated that the foetus actually produces warmth, as Wurster showed that its temperature exceeded that of the interior of the uterus by  $0.5^{\circ}\text{C}$ . or  $0.9^{\circ}\text{F}$ . Champion, in 1903, arrived at a similar conclusion, and put the difference at  $1^{\circ}\text{F}$ .

Very little is known concerning the functions of the intestinal tract of the foetus, though it has been demonstrated that the stomach contains pepsin and rennin after the fifth month, their presence indicating a certain amount of glandular activity. The large amount of blood which circulates through the liver would go to show that this organ serves some important purpose, and the formation of bile is conclusively demonstrated by the presence of biliary materials in the meconium.

While the foetus remains in the uterus its movements are restricted within narrow limits, though such undoubtedly occur, being felt by the mother as "life" from the middle of pregnancy, and at a little later period by the physician when he places his hand upon the abdomen. Ahlfeld demonstrated, by the use of the sphygmograph, that the foetus makes very rapid superficial movements—at the rate of sixty to the minute—which he considered represented an abortive type of respiration; but his conclusions have not been accepted by other observers.

**Sex of the New-born Child.**—Statistics show that more boys are born than girls, the proportion, according to the figures given by Rauber, being 106 to 100. Ahlfeld has pointed out that this ratio is still further increased in elderly primiparae; for when the first child is born between the thirtieth and fortieth years, the proportion is 120-130 to 100, which increases to 130-140 to 100 between the fortieth and fiftieth years.

Various theories have been advanced from time to time in explanation of this fact, but none of them are altogether satisfactory. Those who are interested in the subject are referred to the monograph of Rauber for detailed information.

Until very recently we were almost absolutely ignorant concerning the



causation of sex, though it was generally believed that it did not become established until some time after fertilization. Recent investigations, on the other hand, clearly show that this is not the case, but that it is determined in the germ cells, either primarily or immediately after their union, so that it has become immutable by the time segmentation of the ovum begins.

Lenhossek and Morgan gave excellent reviews of the subject in 1903, and the former pointed out in certain species, at least, that the determination occurred in the ovum. He showed in *Dinophilus*, a sea worm, that two varieties of ova could be distinguished, and that male and female individuals could be produced at will, according to the variety of egg selected for fertilization. Moreover, he found that the relative number of the two kinds of ova could be altered by changing the environment and food of the animals, so that more males or more females could be produced, but at the same time each ovum retained its specificity. Some support is lent to such a view by observations upon human twin pregnancy, as it is well known when the twins are derived from the same ovum that they are always of the same sex, whereas when each is derived from a separate ovum, the sex may or may not be the same.

On the other hand, Wilson, Stevens, Boveri, and others contend that in other species the determining factor must be attributed to the spermatozoon. These investigators have carefully studied the arrangement of the chromosomes in numerous insects, and in some species have discovered that they are differently arranged in the germ cells. Thus, in the oocytes, the chromosomes are always in pairs of similar appearance, while in the spermatoocytes three types may be observed. In the first, one of the chromosomes is without a mate; in the second, the chromosomes in one pair differ in size, one being much larger than its mate; while in the third, no difference can be detected. Accordingly, when reduction occurs in the formation of the spermatozoa, two varieties of the latter will occur in each of the first two types, while in the last all of the chromosomes will be identical. In the first type one variety of spermatozoa will contain one less chromosome than the other, while in the second type both varieties will contain the typical number; but one variety will possess an aberrant, a small chromosome, while the others all will be similar. According to Wilson's theory, sex will depend upon which variety of spermatozoon effects fertilization, those with identical chromosomes giving rise to females, and those lacking a chromosome, or provided with a small one, giving rise to males. Whether the determination is effected solely by the spermatozoon, or whether it merely brings to the ovum certain substances which set in motion tendencies which already existed, is not yet known. In the latter event, the determination of sex must eventually prove to be a function of the ovum.

In 1897 Schenk startled the world by stating that sex could be determined at will, as it was entirely dependent upon the condition of nutrition of the mother, and could therefore be influenced by appropriate dietetic treatment. The considerations just mentioned, however, show that his conclusions were visionary.

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## SECTION III

### *PHYSIOLOGY OF PREGNANCY*

#### CHAPTER VI

#### CHANGES IN THE MATERNAL ORGANISM RESULTING FROM PREGNANCY

It should be constantly borne in mind that pregnancy is not a mere local condition affecting the genitalia, but that every portion of the maternal organism reacts to a greater or lesser extent under its influence. Formerly, the latter changes were attributed in great part to nervous impulses originating in the pregnant uterus, but more extended clinical observation and experimental work clearly show that such is not the case, and indicate that such changes can be explained only by the supposition that they are in some way connected with the circulation in the blood of substances concerning whose nature we are as yet wholly ignorant.

#### UTERUS

Naturally the most marked changes are observed in the generative tract, and especially in the uterus, which undergoes a very great increase in size. Thus, it is converted from a small, almost solid organ, 6.5 centimeters long, into a thin-walled, muscular sac, capable of containing the foetus, placenta, and a large quantity of amniotic fluid, and at the end of pregnancy is about 36 centimeters long, 25 centimeters wide, and 24 centimeters deep. Krause estimated that its capacity is increased 519 times. A corresponding increase in weight is also observed, the uterus at full term weighing in the neighborhood of 1,000 grams (2 pounds), as compared with 30 grams (1 ounce) in the virginal condition.

This enlargement is due principally to the hypertrophy of preëxisting muscle cells, but partly also to the formation of new ones during the earlier months of pregnancy. The fully developed muscle fibers are from 2 to 7 times wider and from 7 to 11 times longer than those observed in the non-pregnant uterus, measuring 0.009 to 0.014 x 0.2 to 0.52 millimeter in the former, as compared with 0.005 x 0.05 to 0.07 millimeter in the latter. According to the researches of Luschka and Veit, the formation of new muscular fibers is limited to the first three or four months of pregnancy.

With the increase in the number and size of the muscle fibers is associated a marked development of elastic tissue. D'Erchia has shown that it forms a network about the various muscle bundles, which hypertrophies with advancing pregnancy, and thus adds materially to the strength of the uterine walls. At the same time there is a great increase in the size of the blood-vessels, especially the veins, which, in the neighborhood of the placental site, become converted into large spaces, the so-called placental sinuses. Marked hypertrophy of the lymphatic and nervous supply of the uterus also takes place, which is well illustrated by the statement of Frankenhäuser that the cervical ganglion increases in size from 2 x 2.5 to 4.5 x 6 centimeters.

During the first few months the hypertrophy of the uterus results from general systemic changes induced by the pregnancy itself, and, in all probability, is brought about by the circulation of certain substances derived from the ovum or corpus luteum. That it is not directly due to the presence of the ovum in the uterine cavity is shown by the occurrence of precisely similar changes in cases of extra-uterine pregnancy, when the ovum is implanted in the tube or ovary. After the third month, however, the increase in size is mechanical to some extent, and is due directly to the pressure exerted by the growing product of conception.

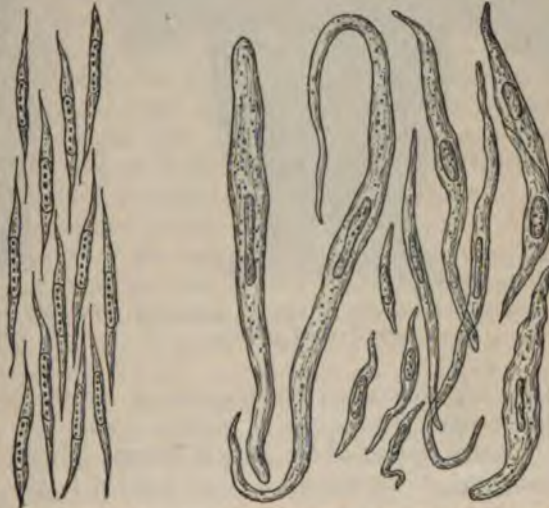


FIG. 175.—MUSCLE FIBERS FROM NON-PREGNANT AND PREGNANT UTERUS (Sappey).

During the first few months of pregnancy the uterine walls are considerably thicker than in the non-pregnant condition, but as gestation advances they gradually become thinner, so that at the end of the fifth month they are from 3 to 5 millimeters in thickness. This measurement is retained throughout the succeeding months, so that at term the uterus is represented by a muscular sac whose walls are rarely above 5, and never more than 10, millimeters thick. Occasionally they are found to measure considerably under 5 millimeters. The enlargement of the uterus is not symmetrical, but is most marked in the fundal region. This can readily be appreciated by observing the relative positions of the insertions of the tubes and ovarian ligaments, which in the early months of pregnancy are almost on a level with the fundus; whereas in the later months their attachments are found at points slightly above the middle of the organ.

The position of the placenta also exerts a determining influence upon

the extent of the hypertrophy, the portion of the uterus to which it is attached enlarging more rapidly than the others, as is clearly shown by the position of the uterine ends of the round ligaments, which are



FIG. 176.—EXTERNAL MUSCULAR LAYER OF PREGNANT UTERUS (Hélie).

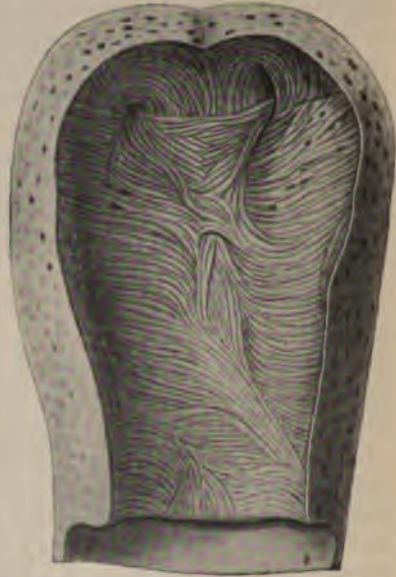


FIG. 177.—INTERNAL MUSCULAR LAYER OF PREGNANT UTERUS (Hélie).

close together when the placenta is inserted upon the posterior, and far apart when it is upon the anterior wall.

**Arrangement of the Muscle Fibers.**—Ever since the time of Vesalius, considerable attention has been devoted to the arrangement of the muscle



FIG. 178.—MEDIAN MUSCULAR LAYER OF PREGNANT UTERUS (Hélie).

fibers in the pregnant uterus. Among the numerous investigators whose careful studies on this subject deserve special mention are William Hunter in England; Madame Boivin, Deville, and Hélie in France; Roederer, Luschka, Henle, Hoffmann, Bayer, Hofmeier, and others in Germany. Unfortunately their investigations have not led to uniform results.

According to Luschka and Henle, the musculature of the pregnant uterus is arranged in three strata: an external hood-like layer, which arches over the fundus and extends into the various ligaments; and an internal layer, consisting of sphincter-like fibers around the orifices of the tubes and



the internal os; while lying between the two is a dense network of muscle fibers perforated in all directions by blood-vessels.

The most important contributions, however, we owe to H  lie, Bayer, and Ruge. In the preface to his monograph H  lie tells us that he had devoted twelve years to his investigations, and Bayer has been an indefatigable worker upon the subject since 1886.

According to H  lie, the uterine musculature consists of three main layers, each of which is made up of several subsidiary divisions. The external layer is composed of two longitudinal or ansiform portions, between which lies a transverse layer. The internal layer is composed of two triangular portions running along the inner surface of the anterior and posterior walls of the uterus respectively, and connected by an archiform layer at the fundus, an obicular portion around each tubal opening, and an annular layer around the internal os. The main portion of the uterine wall is formed by the middle layer, which consists of an interlacing network of muscle fibers, between which extend the blood-vessels. Each fiber comprising this layer has a double curve, so that the interlacement of any two gives approximately the form of the figure "8." As a result of such an arrangement, it happens that when the fibers contract they constrict the vessels and thus act as living ligatures. Bayer's work is extremely complicated, and those who desire particulars concerning it are referred to his monographs upon the subject.

Ruge pointed out that many of the layers which had been described by previous observers do not exist as such in the pregnant uterus, the appearances having resulted from the manner in which the dissections had been made. He showed that the muscle fibers composing the uterine wall, especially in its lower portion, overlap one another and are arranged more or less like shingles on a roof, one end of each fiber arising beneath the peritoneal covering of the uterus, and extending obliquely downward and inward, to be inserted into the decidua, thus giving rise to a large number of muscular lamell  . The various lamell   are connected with one another by short muscular processes, so that when the tissue is slightly spread apart it presents a sieve-like appearance, which on closer examination is seen to be due to the presence of innumerable rhomboidal spaces. Ruge attaches great importance to this arrangement of the muscle fibers, and believes that it explains very satisfactorily the mechanism of the uterine contractions, and the manner in which the felt-like structure of the puerperal uterus is brought about.

**Changes in Size and Shape of the Uterus.**—As the uterus increases in size, it also undergoes important modifications in shape. For the first few weeks its original pyriform outlines are retained, but the body and fundus soon assume a more globular form, which at the third or fourth month becomes almost spherical. After this period, however, the organ increases more rapidly in length than in width, and assumes an oval form, which persists until the end of pregnancy.

The increase in the size of the uterus is limited almost entirely to its body, the cervix remaining practically unchanged until the onset of labor, so that throughout the course of pregnancy it appears as a mere

appendage to the enlarged body. Its most characteristic change consists in a marked softening, which is readily appreciated by the examining finger, and constitutes one of the physical signs of pregnancy. The slight increase in size which can be noted is due in great part to increased vascularity, and depends only to a small extent upon hypertrophy of its muscle fibers. As a result, the secretion of the cervical glands becomes more copious and the cervical canal becomes filled with a plug of mucus. The changes occurring in it in the latter part of pregnancy will be considered in detail when we take up the physiology of labor.



Fig. 179.



Fig. 180.

FIGS. 179, 180.—SAME FULL-TERM I-PARA IN VERTICAL AND HORIZONTAL POSITION.

As the body of the uterus becomes larger, the angle which it forms with the cervix becomes smaller—in other words, its physiological ante flexion is increased. As pregnancy advances the organ soon becomes too large to be contained in the pelvic cavity, and by the fourth month forms a tumor, the upper border of which reaches to a point midway between the symphysis pubis and the umbilicus. As it becomes still larger, it comes in contact with the anterior abdominal wall, displacing the intestines to the sides of the abdomen, and gradually rises up until it almost impinges



upon the liver. As the uterus leaves the pelvis for the abdominal cavity, considerable tension is exerted upon the broad ligaments, which then become more or less unfolded at their median and lower portions and thus contribute to the mobility of the pelvic peritoneum, which is characteristic of pregnancy.

The pregnant uterus possesses a considerable degree of mobility. Since its upper portion projects into and lies free in the abdominal cavity, and its lower portion is held in check by the cervical attachments, it readily changes its position. With the woman in a standing posture its longitudinal axis corresponds closely with that of the superior strait, the organ resting in great part upon the anterior abdominal wall, but, when lying on her back, the uterus falls backward and rests upon the vertebral column. Figs. 179 and 180 represent the same woman in the upright and horizontal positions respectively, and give a good idea of the changes in contour of the uterus and abdomen.

As the uterus grows out of the pelvic cavity, it usually becomes slightly twisted to the right, so that its left margin is directed more anteriorly than the right. Occasionally the torsion may be in the opposite direction, statistics showing that it occurs to the right in 80 per cent. and to the left in 20 per cent. of the cases. The torsion is due in great part to the presence of the rectum, which usually occupies the left side of the pelvis; though possibly, in a certain number of instances, the condition represents merely an exaggeration of the original position of the non-pregnant uterus, which, as is well known, is not always perfectly symmetrical. From my own observations, I am inclined to agree with Webster, that the frequency with which torsion of the uterus occurs has been somewhat exaggerated.

The uterus soon loses the firm, almost cartilaginous consistence which is characteristic of the non-pregnant condition, and, with the advance of pregnancy, becomes converted into a sac having very thin, soft walls, which are readily compressible. This is well demonstrated by the ease with which the foetus can usually be palpated, and by the fact that not infrequently it is possible at abdominal operations to observe shallow depressions upon the surface of the uterus, which have resulted from the pressure of the intestines upon it. Again, it is noteworthy with what readiness the uterine walls yield to the movements of the foetal extremities.

## TUBES AND OVARIES

As has already been mentioned, the tubes and ovaries undergo marked changes in position with the advance of pregnancy, so that instead of extending outward almost at right angles with the cornua, their long axes become nearly parallel to the margins of the uterus. Of special importance, moreover, is their increase in vascularity, to which the large size of the corpus luteum of pregnancy is in great part due. Except in rare instances, ovulation ceases during pregnancy, so that new follicles do not ripen, and, accordingly, only the single large corpus luteum of pregnancy



can be found upon the surface of one of the ovaries. Seitz, in 1905, after an exhaustive study, concluded that typical ovulation does not occur, but that many follicles begin to grow and, after reaching a certain period of development, undergo atretic changes, associated with a marked development of lutein cells in the theca folliculi.

It is generally stated that the muscular fibers of the tubes undergo considerable hypertrophy under the influence of pregnancy, but I believe that Mandl is correct in stating that, if it occurs at all, it is very slight in extent. It is possible for a decidua to develop in the tubes while the pregnancy is situated in the uterus. Such observations have been made by Webster, Mandl, and Veit, but are of extreme rarity. I have met with such an occurrence in only one instance.

### VAGINA

Increased vascularity is the most marked change in the vagina, and to it are due the more copious secretion and the characteristic violet coloration of pregnancy. At the same time there is considerable hypertrophy of the elements composing the vaginal walls, the latter not infrequently increasing in length to such an extent that the lower portion of the anterior wall prolapses slightly through the vulval opening.

The papillæ of the vaginal mucosa also undergo considerable hypertrophy, whence results an increased roughness of the membrane, which in occasional instances feels almost like a calf's tongue. Owing to the increased vascularity, the vaginal secretion is considerably augmented, and in the majority of cases is represented by a thick, white, crumbly substance, somewhat like cottage cheese, which possesses a distinctly acid reaction. Döderlein showed that it consists of epithelial cells and a large number of long, tolerably thin bacilli, but that under normal conditions it does not contain leukocytes or pathogenic microorganisms. Zweifel in 1908 showed that the acid reaction is due to the presence of lactic acid, which he believes plays a marked part in preventing the growth of pathogenic bacteria.

The increased vascularity attending pregnancy is not confined to the genitalia, but extends to the various organs in their vicinity, and as a consequence there is a slight relaxation of the various pelvic joints, which is accompanied by an increase in their motility, as was conclusively shown by Budin.

### ABDOMINAL WALLS

With the enlargement of the uterus the skin covering the anterior abdominal walls and the adjoining portions of the thighs is subjected to considerable tension, which, according to Zeiler, results in the rupture of the elastic fibers of the reticular stratum of the cutis, and the formation of depressed areas which are known as the *striae of pregnancy*. In primiparae these present a pinkish or slightly bluish appearance, as is well illustrated in Fig. 181, whereas in multiparae two varieties are

observed, some resembling those of primiparous women, while others present a glistening silvery appearance, the former resulting from the present condition, and the latter representing cicatrices from previous pregnancies.

The formation of striae is not characteristic of pregnancy, as it is lacking, according to Credé, in about 10 per cent. of the cases and is not infrequently observed in non-pregnant women and occasionally in men, in



FIG. 181.—ABDOMEN OF PRIMIPARA AT TERM, SHOWING STRIÆ.

whom there has been a rapid increase in the size of the abdomen, either from the presence of a tumor or ascites, or the rapid development of fat.

Not infrequently the abdominal walls are unable to withstand the tension to which they are subjected, and the recti muscles become separated in the middle line, giving rise to a *diastasis* of greater or less extent. Where the process is exaggerated, a considerable portion of the anterior wall of the uterus is covered by nothing beyond a thin layer of tissue consisting only of skin, fascia, and peritoneum. In rare instances the separation is sufficiently extensive to admit of a hernial protrusion of the gravid uterus.

The enlarged pregnant uterus occasionally presses upon the venous trunks, which return the blood from the lower extremities, the obstruction being sometimes sufficient to cause varicose veins or *œdema*. The latter is

most commonly observed about the ankles and feet, but occasionally occurs to a marked degree in the neighborhood of the vulva, when the labia majora may become immensely distended.

### BREASTS

Under the influence of pregnancy marked changes occur in the breasts, and in the early weeks the woman not infrequently complains of a sense of tenseness and pricking in these regions. After the second month the breasts begin to increase in size and offer a somewhat nodular sensation on palpation, which is due to the hypertrophy of the mammary alveoli, and as they become still larger a delicate tracery of bluish veins appears just beneath the skin. Even more characteristic, however, are the changes occurring in the nipples and the tissues in their vicinity. The nipples themselves soon become considerably larger, more deeply pigmented, and more erectile, and after the first few months a thin, yellowish fluid—*colostrum*—may be expressed from them by gentle massage. At the same time the areola surrounding the nipple becomes considerably broader and much more deeply pigmented, the degree of pigmentation varying according to the complexion of the individual. In blondes the areolæ and nipples assume a pinkish appearance, while in brunettes they become dark brown and occasionally almost black. Scattered through the areola are a number of small roundish elevations, the so-called *glands of Montgomery*, which result from the hypertrophy of the sebaceous glands. In a small number of cases similar structures make their appearance in a less deeply pigmented area outside of the periphery of the areola, and which is designated as the *secondary areola*. If the increase in the size of the breasts be very marked, the skin not infrequently presents striations similar to those observed on the abdomen.

### CHANGES IN THE REST OF THE BODY

Formerly it was believed that direct nervous connection existed between the uterus and the breasts, but the demonstration that lactation can be established after excluding the spinal nervous mechanism by severing all nerves supplying the breast, or even after transplanting the organ to other portions of the body, clearly indicates that some other factor must be invoked in explanation of the mammary changes in pregnancy. Starling and Lane Claypon in 1906 stated that they were able to produce marked hypertrophy of the breasts of virginal rabbits by the injection of extracts obtained from the bodies of foetal rabbits, and attributed the result to certain specific hormones. Their conclusions were generally accepted until 1911, when Frank and Unger stated that they were unable to confirm them and attributed them to faulty observation and technique. However that may be, there is at present no doubt that the mammary changes characteristic of pregnancy must be due to the action of specific substances circulating in the blood, as was demonstrated by the observations of



Schauta and of Basch upon the Blazek sisters. In this instance one of the pygopagous twins gave birth to a child, which could be suckled equally well by its own mother or by her nulliparous sister.

As already indicated, the changes resulting from pregnancy involve nearly every portion of the body, and in many cases the general condition of the patient differs markedly from what it was before conception. Many women suffer numerous inconveniences, while others enjoy better health than at any other time.

**Heart.**—Owing to the upward pressure upon the diaphragm, the heart becomes displaced in such a way that its area of dullness undergoes a considerable increase in size. Basing his opinion upon this fact, Larcher in 1827 promulgated the doctrine that considerable cardiac hypertrophy was a constant concomitant of pregnancy. His views obtained rapid acceptance in France, but were received with skepticism in Germany. On the other hand, the researches of Dreysel indicate that it does take place, as he found that the hearts of 76 pregnant and puerperal women weighed 8.8 per cent. more than those of non-pregnant individuals. The question, however, cannot be regarded as definitely settled, and offers an attractive field for future work.

If Fries is correct in stating that the total quantity of blood is not increased during pregnancy, and, as the demands of the enlarging uterus and its contents must be met, it would seem that they could be satisfied only by a more rapid circulation of the blood. As the pulse rate is not materially increased during pregnancy, it appears justifiable to conclude that such a result is accomplished by the heart expelling an increased amount of blood at each beat, which inevitably necessitates increased work, with coincident hypertrophy.

The investigations of Slemons and Goldsborough upon the blood pressure confirm such a view; as they were able by means of Erlanger's sphygmomanometer to demonstrate a considerable increase in the pulse pressure, as well as in the "index" of the work of the heart. This was most marked in the latter months of pregnancy and disappeared during the puerperium; and, as the more extensive observations of Jaschke in 1911 led to similar results, it seems reasonable to believe that the heart undergoes a certain amount of hypertrophy.

**Blood.**—In former times it was generally believed that the changes incident to the placental circulation demanded an increase in the amount of maternal blood, and all the earlier writers stated that under the influence of pregnancy an increased hydræmia and a diminution in hæmoglobin and red corpuscles took place, while at the same time an abnormal amount of fibrin could be noted. These observations were based upon antiquated methods of research, and it was not until 1886 that Fehling, by the aid of modern appliances for examining the blood, came to the conclusion that it underwent little if any change.

Since then a number of articles have appeared upon the subject, the most important being those of Wild in 1897, Zangemeister in 1903, Payer in 1904, and Dietrich in 1911. These investigations show that in the later months of pregnancy the amount of hæmoglobin and of red corpuscles is

normal, or even slightly increased, while there is a slight increase in the number of white cells. The leukocytosis is markedly accentuated at the time of labor, but falls rapidly in the puerperium unless infection supervenes. Similar conclusions were reached by W. L. Thompson in my service.

The specific gravity of the blood is somewhat lowered, and Zangemeister and Landsberg demonstrated a diminished freezing point and a decrease in its albuminous content. In view of the normal quantity of the red cells and hæmoglobin, such a condition cannot properly be called hydramia, so that Zangemeister proposed to designate it as hydroplasmia. Both Zangemeister and Payer noted a decrease in the alkalinity of the blood during pregnancy, but its exact significance is not yet clear.

In all probability the blood also contains various substances which are not present at other times, but our information upon the subject is as yet very vague. In this connection it suffices to note that Gräfenburg has described an increase in the antitryptic ferment content, Neu an increase in the adrenalin content, Chauffard, Laroche, and Grigaud an increase in the cholesterin content, and Heynemann states that there is a marked difference between the serum of pregnant and non-pregnant women, as the former after heating will induce hæmolysis of washed horses' corpuscles in the presence of cobra poison, while the latter will not.

**Respiratory Tract.**—According to Siegmund, Koblanck, and others, more or less characteristic changes may occur in the nasal mucosa. These consist in reddening and thickening of the so-called Fliess's areas, and it is stated that at the time of labor the character of the uterine contractions may be altered by intra-nasal manipulations.

It has long been known that pregnancy may exert a deleterious influence upon the voice of singers, and Hofbauer has shown that it is associated with changes in the larynx which occur in three-quarters of all pregnant women. These consist in reddening and œdema of the false vocal cords, as well as of the inter-arytenoid region. In addition to the usual histological manifestations of inflammation, decidua-like cells make their appearance in the submucosa.

Owing to the upward displacement of the diaphragm in the later months of pregnancy, it would seem as though the capacity of the lungs would be decreased. Nevertheless, Dohrn has shown that such is not the case, since the diminished height of the pleural cavities is compensated for by an increase in width. Furthermore, the investigations of Zuntz and myself upon the respiratory exchange show that, while there is no great increase in the consumption of oxygen or in the output of carbon dioxide, there is nevertheless a great increase in the amount of air inspired.

**Digestive Tract.**—In many instances the early months of pregnancy are complicated by minor disorders of digestion. Frequently these are not independent affections, but are to be regarded as a manifestation of a mild toxæmia.

At least one-half of all pregnant women suffer from constipation. In the later months of pregnancy this may be regarded as being partly due to the pressure of the enlarged uterus, and partly to the loss of tonicity of the abdominal walls resulting from their distention.



During pregnancy the liver is in a state of unstable equilibrium, and is readily affected by various conditions, as is demonstrated by the lesions accompanying eclampsia, vomiting of pregnancy, and acute yellow atrophy of the liver. These conditions will be discussed in detail in the chapter on the toxæmias of pregnancy.

Hofbauer considers that even in normal pregnancy the liver presents characteristic changes, so that one is justified in speaking of the "liver of pregnancy." The changes consist in the appearance of fat in the cells occupying the central portion of the lobules, the disappearance of glycogen, and the dilatation of the biliary channels, the central veins, and the afferent capillaries. No doubt such changes are sometimes noted, and, should they occur as regularly as he believes, they would offer a satisfactory explanation for several of the alterations in metabolism which characterize pregnancy.

**Urinary Tract.**—The kidneys are likewise under a considerably increased strain during pregnancy, and slight degrees of nephritis are so common that they are assigned by the Germans to the "kidney of pregnancy." Such conditions are usually connected with the various disturbances of metabolism associated with the toxæmias of pregnancy and will be considered under that heading, while various alterations in the constitution of the urine in normal pregnancy will be taken up below in the section on General Metabolism.

The ureters are sometimes compressed by the growing uterus, and under such conditions a mild infectious process, which otherwise might not give rise to symptoms, may eventuate in a pyelitis or pyelonephrosis.

In the early months the bladder is more or less compressed by the growing uterus, and consequently increased frequency of micturition is often noted. As the uterus rises up into the abdominal cavity it carries with it the bladder, which then becomes an abdominal rather than a pelvic organ. Corresponding to the torsion of the uterus about its vertical axis, the bladder is pushed to the right side of the abdomen in possibly 90 per cent. of all pregnant women.

**Ductless Glands.**—Lange in 1899 reported that the thyroid gland was definitely hypertrophied in 108 out of 133 women examined in the last three months of pregnancy. As albuminuria was present in 18 of the women in whom no hypertrophy was noted, he naturally thought that there might be some direct relation between its absence and the urinary changes. With this in mind, he administered iodothylin to a number of albuminuric pregnant women, and in some instances noted a rapid disappearance of the albumin. He expressed himself very conservatively concerning the matter, but his views were promptly taken up by Nicholson and others, and made the basis for a theory concerning the mode of production and treatment of eclampsia and the toxæmias of pregnancy.

My own experience shows that a moderate degree of hypertrophy of the thyroid is a usual concomitant of normal pregnancy, while the effect of its absence will be considered in the chapter upon the toxæmias of pregnancy.

There is considerable evidence that the parathyroids also undergo a



similar hypertrophy, whose absence is manifested by the appearance of various untoward symptoms.

Since Launois and Mulon, in 1904, directed attention to an hypertrophy of the hypophysis during pregnancy, a great deal of work has been done upon the subject, and the investigations of Eisemann and Stumme, Cushing, Mayer, and others have definitely shown that the anterior lobe of the gland regularly undergoes great hypertrophy during pregnancy, and atrophies after its completion. The hypertrophy, which may double the size of the gland, is due in great part to a marked increase in the number and size of the "Hauptzellen." Its significance is not yet clear, but it has been suggested that the hypophyseal secretion may supplement a supposed deficiency in that derived from the ovaries. Furthermore, on account of the known relation existing between abnormalities of the hypophysis and the development of acromegaly, a similar origin has been suggested for the non-œdematous thickening of the features, as well as of the extremities, which is observed in so many pregnant women.

The posterior or infundibular portion of the hypophysis, in addition to its effect upon the blood pressure, possesses the power of markedly stimulating uterine contractions, as has been shown by Dale, Bell, Parisot, and others. Whether it is normally concerned in the regulation of uterine contractions at the time of labor is not known, but Hofbauer, Parisot and Spire, and others have demonstrated that it may be advantageously employed to stimulate contractions in certain cases of uterine inertia.

That the changes in the ductless glands are not limited to those just mentioned is shown by the fact that Neu has demonstrated that the blood in the later months of pregnancy is ten times richer in adrenalin than at other times, which would imply an hypertrophy, or at least an increase, in the secretory activity of the suprarenal capsules.

**Skeleton and Teeth.**—Rokitansky described the formation of irregularly shaped plaques of porous, newly formed bone, or osteoid tissue, upon the internal surface of the cranial bones during pregnancy. These he designated as puerperal osteophytes, but neither he nor the subsequent observers who have confirmed his findings are clear as to their significance.

Hanau considers that they are most pronounced in those cases in which there occurs an excessive formation of osteoid tissue in other parts of the body. This he is inclined to attribute to a slight grade of osteomalacia, which he, Gelpke, and Wild regard as physiological in all pregnancies, and associated with the supply of calcium salts to the fœtus. Dibbelt estimates that throughout the second half of pregnancy at least 0.17 gram of calcium oxide must be supplied to the fœtus each day, while Bar calculates that during the last two months the quantity must be increased to 0.638 gram per day. It is therefore evident, unless the pregnant woman assimilates an unusual amount of calcium from her food, that the fœtus must be supplied from her own body, and this is usually effected by partial decalcification of the bones and teeth. For that reason the teeth are prone to decay rapidly, so that the expression "for every child a tooth" has become proverbial.

Owing to the increased vascularity, the various pelvic joints become

more succulent and permit greater mobility. Occasionally they become so relaxed that locomotion is seriously interfered with. The treatment of this abnormality will be considered in the chapter upon the pathology of pregnancy.

**Nervous System.**—Various disturbances of the nervous system occur during pregnancy, but as they are distinctly abnormal they will be considered later. On the other hand, mild degrees of disturbed mental equilibrium are so frequently observed as to be considered almost physiological. In this category may be placed the longings and cravings for unusual or abnormal articles of diet. Many women also experience pronounced changes in disposition, and not a few multiparous patients recognize the occurrence of pregnancy by their appearance. Again, in those of neuropathic tendencies the mental equilibrium may be overthrown to a greater or less degree, the patient becoming excitable, morbid, or morose, and in rare instances developing a true psychosis.

**Skin.**—Reference has already been made to the formation of striae and to the pigmentation of the nipple and areola. In other cases the linea alba becomes markedly pigmented, and occasionally irregularly shaped, yellowish patches of varying size appear on the face and neck, the condition being known as *cloasma*. Very little is known concerning the nature of those conditions, but Wychgel has demonstrated that the pigment deposited in the papillary layer of the skin responds to the usual tests for iron. He considers that it is derived from the hæmoglobin of the maternal blood-cells which have succumbed in the fight against the foetal tissues.

**General Metabolism.**—Generally speaking, gestation is characterized by improved health. In some instances the improvement in nutrition is noted shortly after conception, but usually does not become manifest for several months. For this reason it is frequently possible to distinguish two periods in pregnancy. The earlier is characterized by lassitude, mental depression, and some loss of weight, while the latter is conspicuous for an excellent condition of body and mind.

Analogous conditions have been observed in pregnant dogs, rabbits, and guinea-pigs by Hagemann, Ver Eecke, Jägeroos, Bar, and Murlin. Those interested in the subject are referred particularly to the monumental metabolic studies of Bar, which clearly show that katabolic processes are most prominent in the first half of pregnancy, as is indicated by the fact that more material is excreted than ingested, whereas the reverse obtains in the second half. During the latter period there is a marked tendency toward storage of the various food stuffs.

As yet we are unacquainted with the metabolic processes in the early months of pregnancy in women, but a number of observations have been made in the weeks immediately preceding delivery. These clearly show that women in the last weeks of pregnancy possess an unusual capacity for storing up the essential elements of their diet, and that their metabolism is analogous to that observed in animals. In 1862 Gassner studied the changes in weight of his patients during the last three months, and found an average monthly increase of from  $3\frac{1}{2}$  to  $5\frac{1}{2}$  pounds. The gain was proportional to the weight of the individual, and was relatively larger in



multigravidæ. Moreover, he considered that the absence of such a gain in weight was indicative of the death of the foetus *in utero*. Confirmatory results were obtained by Baumm, who found that the weekly increase in the last month and a half of pregnancy was approximately 1 per cent. of the body weight.

This gain in weight is in great part due to the retention of water, and its extent may be best appreciated by comparing the intake of fluids with the output of urine. In three normal pregnancies, my associate, J. M. Slemons, found that the latter represented from one-half to three-quarters of the fluid taken by mouth, whereas in a patient with dead twins it amounted to 93 per cent., which is approximately the normal non-pregnant ratio.

The daily output of urine is subject to so many variations, being influenced by climatic, dietetic, and individual peculiarities, that it is difficult to fix a normal standard. Ordinarily the daily quantity varies between 1,000 and 1,500 c. c., though smaller or larger amounts may be excreted without necessarily indicating a pathological condition.

Proteid metabolism in the latter months of pregnancy has been studied by Zacharjewsky, Schrader, Hahl, Hoffström, Hoogenhuyse, and others, who have shown that considerable quantities of nitrogen are retained when the woman is allowed an adequate diet. Similar observations have been made by my clinic during the last few weeks of pregnancy, and the average daily nitrogenous exchange in three women studied by Slemons is given in the accompanying table.

| TYPE.             | Fluid Ingested. | Quantity of Urine. | Nitrogen in Food. | Nitrogen in Urine. | Nitrogen in Fæces. | Nitrogen Balance. |
|-------------------|-----------------|--------------------|-------------------|--------------------|--------------------|-------------------|
| Primigravida..... | 1,780 c. c.     | 1,306 c. c.        | 13.80 gms.        | 12.43 gm.          | 0.95 gm.           | +0.42             |
| Multigravida..... | 1,890 c. c.     | 1,007 c. c.        | 16.77 gms.        | 13.26 gm.          | 0.53 gm.           | +2.98             |
| Twin Pregnancy... | 2,354 c. c.     | 1,135 c. c.        | 15.00 gms.        | 8.28 gms.          | 2.00 gms.          | +4.72             |

Such a storage of nitrogen as shown by these figures would indicate a considerable construction of proteid tissue, and corresponds to the growth of the foetus, placenta, uterus, and the maternal organism in general.

It is generally assumed that the nitrogenous content of the urine is increased during pregnancy on account of the fact that it contains the waste products of both the foetal and maternal metabolism. Such a belief, however, is erroneous, at least in the latter months of pregnancy, as the nitrogen storage to which we have just referred must necessarily be accompanied by a decrease in the urinary nitrogen. This is clearly demonstrated by the ordinary tests made by means of a Doremus ureometer, when the daily output of urea varies between 16 and 24 grams, instead of the higher figures usually given for non-pregnant women of the same weight.

Along with the quantitative change in the elimination of nitrogen are associated certain qualitative variations. Thus, the urea content is relatively low, and represents only 80 to 85 per cent. of the total nitrogen,

instead of 85 to 90 per cent. as in non-pregnant individuals. At the same time there occurs a slight rise in the percentage of ammonia, which is still further accentuated in twin pregnancy. Furthermore, there is usually an increase in the percentage of undetermined nitrogen, a part of which, according to Falk and Hesky, is accounted for by a markedly increased elimination of amino acids and peptid nitrogen. Zacharjewsky found that the uric acid excretion was practically normal, while Boni holds that the quantity of purin bases is somewhat diminished.

In animal experiments of Hagemann, Jägeroos, Harnack and Klein, and Bar, study of the mineral metabolism revealed changes analogous to those observed in the nitrogenous elimination, and indicated a retention of various inorganic substances. The investigations of Schrader, Boni, Hoffström, Zangemeister, and others in women show a similar retention, whose object is to supply the calcium, phosphorus, sulphur, chlorine, etc., essential to the up-building of the foetus. That the mechanism is not always perfect has already been indicated in connection with the calcium metabolism, when it was stated, if sufficient quantities of calcium were not obtained from the food, that the deficit would be made good by the decalcification of the bones and teeth of the mother. Following the delivery of the child or its death *in utero*, the various constituents soon show a tendency to return to the usual non-pregnant relations.

Acetonuria was formerly considered a sign of foetal death, but more recent work shows that it is of no clinical significance. Stolz observed it in more than one-third of a series of 97 normal pregnancies, and Jägeroos demonstrated it in nearly every normal labor. On the other hand, the appearance of the other acetone bodies—diacetic or oxybutyric acid—is always of pathological significance.

The respiratory exchange has been studied in women by means of the Zuntz apparatus by Magnus-Levy, Zuntz, and myself. These investigations show a considerable increase in the total quantity of air inspired, but indicate that the consumption of oxygen and the elimination of carbon dioxide is but little greater than would be expected on account of the increased weight of the pregnant woman.

Carpenter and Murlin in 1911 reported the results of their investigations upon the total energy metabolism of pregnant women by means of a modified Atwater Calorimeter in the Carnegie Nutrition Laboratory in Boston. They found "that the energy metabolism expressed per kilogram and hour is but little larger (4 per cent.) than for a woman in complete sexual rest." Furthermore, they stated, while the energy metabolism of the newly born child was two and a half or three times as great per kilogram of weight as that of the mother, that the total energy metabolism of both mother and child during the first days of puerperium was not greater than before labor.

The more we learn concerning the metabolism of normal pregnancy, the more are we impressed with the fact that the maternal organism in the second half of gestation preserves the strictest economy in its metabolic processes. Its purpose, of course, is to facilitate the upbuilding of the foetus without too great strain upon the mother, but we are as yet



entirely ignorant of the mechanism by which such changes are rendered possible.

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## CHAPTER VII

### DIAGNOSIS OF PREGNANCY—DURATION OF PREGNANCY—ESTIMATION OF DATE OF CONFINEMENT

Ordinarily, the diagnosis of pregnancy offers little or no difficulty, and the patient is usually aware of the true condition before she consults a physician. In a small minority of cases, however, the task is by no means easy, and despite every known method at our command we are occasionally unable to decide with absolute certainty.

Mistakes in diagnosis are most frequently made in the first few months, while the uterus is still a pelvic organ; although it is by no means impossible to confound a pregnancy, even at full term, with a tumor of some other nature. Such errors are usually the result of hasty or imperfect examination, but a false conclusion may sometimes be arrived at, even after the most conscientious exploration of the patient. Some idea of the frequency of such mistakes may be realized when it is stated that there is hardly a gynecologist of experience who has not opened the abdomen on one or more occasions, with the expectation of removing a tumor of the uterus or its appendages, and been surprised to find himself in the presence of a normal pregnancy.

It is often a matter of considerable importance that a diagnosis be made in the early months of pregnancy; but, unfortunately, it is just at this period that our diagnostic ability is most restricted, as the absolutely positive signs do not as a rule become available until the fifth month. Hence, it follows that in cases in which the existence of such a condition might affect the reputation or interests of the patient an expression of opinion should be deferred until the diagnosis is beyond all doubt.

The diagnosis is based upon the presence of certain symptoms and signs. The former are chiefly subjective and are appreciated by the patient; while the latter are made out by the physician after a careful physical examination, in which the senses of sight, hearing, and touch are employed.

The signs and symptoms are usually classified into three groups: the positive signs, which cannot usually be detected until after the fourth month; the probable signs, which can be appreciated at an earlier period; and the presumptive evidences, which are usually subjective in character, and may be experienced at varying periods.

**Positive Signs of Pregnancy.**—These are three in number, and consist in (1) hearing and counting the foetal heart beat, (2) perception of the

active and passive movements of the foetus, and (3) ability to palpate its outlines.

*The Fœtal Heart.*—Whenever we can hear and count the pulsations of the foetal heart, the diagnosis of pregnancy is assured beyond peradventure; unfortunately, this sign cannot usually be appreciated until the eighteenth or twentieth week, though Sarwey and Benoist claim that it may be possible as early as the twelfth or fourteenth week.

The foetal heart was first heard by Mayor, of Geneva, in 1818, but was recognized independently by Lejumeau de Kegaradec in 1821, to whom we are indebted for most of our information upon the subject; indeed, so complete is his monograph that subsequent investigations have revealed but little with which he was not familiar. He made his discovery quite accidentally, while attempting to hear the sounds which he supposed would be made by the foetus splashing in the liquor amnii. On auscultating the abdomen of a pregnant woman through her clothing, including the corset, he heard a double sound, which varied in frequency from 143 to 148 beats to the minute, and closely resembled the ticking of a watch under a pillow. He concluded that it could be produced only by the foetal heart, as the pulse of the mother did not exceed 70. For further details concerning the history and earlier work upon the subject the reader is referred to the works of Kegaradec, Kennedy, Depaul, and Montgomery.

The *fœtal heart-beat*, after the eighteenth or twentieth week of pregnancy, should be detected without difficulty. Ordinarily it varies in frequency from 120 to 140 beats to the minute, and is a double sound, closely resembling the tick of a watch under a pillow. In order to hear it the abdomen should be bared, or at most covered by a thin cloth. In the earlier months it is best detected by means of a stethoscope, but at a later period the direct application of the ear gives more satisfactory results, so that it is advisable for the student to perfect himself in the latter method of auscultation. One should not be content with merely hearing the foetal heart, but should always attempt to count its rate and compare it with that of the maternal pulse.

In the early months the heart should be sought just over the symphysis pubis; but in the later months the situation at which it is best heard varies according to the position and presentation of the foetus, details concerning which will be given when we consider the methods of obstetrical examination.

The rate of the foetal heart is subject to considerable variations, which afford us a fairly reliable means of judging as to the well-being of the child. As a general rule, its life should be considered in danger when the heart-beats fall below 100 or exceed 160. Frankenhäuser stated that there was a marked difference in the rapidity of the heart-beat in the two sexes, and believed that a rate of 124 or less indicated a boy, and 144 or more a girl. Further investigation, however, has failed to confirm his conclusions, as the diagnosis of sex can be made by this means in only about 50 per cent. of the cases. Indeed, there is no method by which the sex can be definitely determined before birth, except in a few cases of breech presentation, in which the genitalia can be differentiated by the examining finger.



In women possessing very thin abdominal and uterine walls the impulse of the foetal heart may occasionally be appreciated by direct palpation, especially when the child is lying in the right mento-iliac position. Such observations have been reported by Fischel, Duval, and others.

*Other Sounds Which May Be Heard on Auscultation.*—In addition to hearing and counting the foetal heart, auscultation of the abdomen in the later months of pregnancy often reveals other sounds, the most important of which are the funic souffle, the uterine or placental souffle, sounds due to movements of the foetus, the maternal pulse, and the gurgling of gas in the intestines of the mother.

The *funic souffle* is a sharp, whistling sound, synchronous with the foetal pulse, which can be heard in about 15 per cent. of all cases. It is very inconstant in its appearance, as it may be recognized distinctly at one examination and be absent on succeeding occasions. It was first described by Every Kennedy, who supposed that it was due to some interference with the circulation of the blood through the umbilical arteries, and subsequent investigations have served to confirm his conclusions. Its mode of production may occasionally be demonstrated in very thin women, in whom the umbilical cord may be palpated between the body of the child and the uterine wall, and on making pressure upon it with the stethoscope a distinct souffle can occasionally be elicited. This is not, however, a sign of very great importance, although, when heard, it is distinctly characteristic of pregnancy.

The *uterine souffle* is a soft, blowing sound, synchronous with the maternal pulse, and is usually most distinctly heard upon auscultating the lower portion of the uterus. It is due to the passage of blood through the dilated uterine vessels. This sound was first described by Kegaradec, who considered that it was produced by the circulation of the blood through the placenta. He therefore designated it as the *placental souffle*, and believed that it was of value in determining the situation of that organ. Subsequent investigations, however, have shown that such is not the case, and that the sound originates as I have indicated. As stated by Rotter and others, it may occasionally be appreciated by the palpating finger. This sign is not characteristic of pregnancy, as it may be present in any condition in which the blood supply to the genitalia becomes markedly increased, and accordingly may be heard in non-pregnant women presenting tumors of the uterus or ovaries.

Certain *movements of the fetus* may likewise be recognized on auscultation. According to Ahlfeld, it is impossible to hear the movements of the extremities, and he considers that the sounds which are usually so interpreted are produced by spasmodic contractions of the diaphragm, and are analogous to singultus.

Not infrequently the *maternal pulse* can be distinctly heard on auscultating the abdomen, and in some instances the pulsation of the aorta is so violent as to communicate a distinct throb to the ear. Occasionally, in neurotic women, the pulse may become so rapid during examination as to mask the foetal heart sounds.

In addition to the sounds just mentioned, it is not unusual to hear

certain others produced by the passage of gases or fluids through the intestines of the mother.

*Mapping Out the Outlines of the Fœtus.*—In the latter half of pregnancy it is possible to distinguish the outlines of the fœtus by palpation through the abdominal walls, and this becomes easier the nearer term is approached. When we desire to map out the fœtus we should go about the examination in a methodical manner, and follow the rules for palpation which will be given later.

A diagnosis of pregnancy should not be made from this sign alone, unless one is able to feel distinctly the various portions of the fœtus and distinguish its head, breech, back, and extremities. Subserous myomata occasionally simulate the head or small parts, or both, and their presence has occasionally given rise to serious diagnostic errors.

*Movements of the Fœtus.*—The third positive sign of pregnancy is present whenever the physician is able to feel the spontaneous movements of the fœtus.

After the fifth month the *active movements* may be felt at intervals on placing the hand over the abdomen. These vary from a faint flutter in the early months to quite violent motions at a later period, which not infrequently are visible as well. Occasionally, somewhat similar sensations may be produced by contractions of the intestines or the muscles of the abdominal wall, though these should not deceive an experienced observer.

The *passive movements*, obtained by *ballottement*, consist in the rebound of a fœtal extremity when displaced from its position by the examining finger, whereby a sensation is afforded similar to that produced when a sudden motion is given to a piece of ice in a glass of water, so that at first it sinks and then slowly comes back to the finger. This sign is available from the early part of the fourth month, and may be obtained through either the vagina or the abdominal walls. To obtain vaginal ballottement the patient should be on her back; the physician then introduces two fingers into the vagina and carries them up to the anterior fornix, to which he imparts a sudden motion with his finger-tips, afterward retaining them in the same position. After a moment the extremity of the child, which occupies the lower segment of the uterus, usually the head, drops down upon them again.

External ballottement can be obtained by imparting a sudden motion to the portion of the abdominal wall covering the uterus; in a few seconds the rebound of one of the extremities or of the head of the fœtus can be felt. This sign, while not absolutely positive, is of very considerable value, as it can be simulated only by a pedunculated tumor swimming in ascitic fluid. When any one of the three positive signs is obtained, the diagnosis of pregnancy is established beyond doubt.

**Probable Signs of Pregnancy.**—These consist in (1) enlargement of the abdomen; (2) changes in the shape, size and consistency of the uterus; (3) changes in the cervix, and (4) the detection of intermittent contractions of the uterus.

*Enlargement of the Abdomen.*—From the third month onward the uterus can be felt through the abdominal walls as a tumor, which gradually



increases in size up to the end of pregnancy. Generally speaking, any enlargement of the abdomen during the childbearing period should be regarded as *prima facie* evidence of the existence of pregnancy. Figs.



Fig. 182.

Fig. 183.

Fig. 184.

Fig. 185.

FIGS. 182-185.—SHOWING RELATIVE ABDOMINAL ENLARGEMENT AT THIRD, SIXTH, NINTH, AND TENTH MONTH OF PREGNANCY.

182, 183, 184, and 185 give a good idea of the changes in the shape of the abdomen at the various months.

The abdominal enlargement is less pronounced in primiparæ than in multiparæ, for the reason that in the latter the abdominal walls have lost a great part of their tonicity and are sometimes so flaccid that they afford little or no support to the uterus, which then becomes markedly anteflexed and sags forward and downward, giving rise to a *pendulous abdomen*. This difference is so apparent that it is not unusual for women in the latter part of a second pregnancy to suspect the existence of twins from the increased size of the uterus, as compared with that noted in the corresponding month of the previous pregnancy. It should also be borne in mind that the abdomen changes its shape materially according as the woman is in the upright or horizontal position, being much less prominent when she is lying down. (See Figs. 179 and 180.)

*Changes in Size, Shape, and Consistency of Uterus.*—In the first three months these are the only physical signs available, and the existence of an enlarged uterus at any time during the childbearing period should be regarded as presumptive evidence of pregnancy, until such a possibility has been conclusively eliminated.

During the first few weeks the increase in size is limited almost entirely to the antero-posterior diameter; but at a little later period the body of the uterus becomes almost globular in shape, and at the third month attains the size of an orange. During the first two months the pregnant uterus still continues to be entirely a pelvic organ, whereas during the third month it begins to rise above the symphysis. At the same time the angle between the body and cervix becomes markedly accentuated—in other words, the physiological ante flexion is increased.

More characteristic than the changes in shape are those affecting its consistency. On bimanual examination the uterine body offers a doughy or elastic sensation, and in many instances becomes so soft as to be hardly distinguishable. Dickinson has pointed out that these changes can be noted at a very early period, and states that he was able to differentiate a symmetrical elastic area in the body of the uterus in the latter part of the first week of pregnancy, which he considered almost pathognomonic.

According to R. von Braun, it would appear that as early as the first week evidence of pregnancy is afforded by the appearance of a more or less longitudinal furrow upon either the anterior or posterior surface of the uterus. Its presence he attributes to changes in consistence and the alteration between contraction and relaxation of the portion of the organ in which the ovum is situated.

At about the sixth week another sign of very considerable value—the so-called *Hegar's sign*—becomes available. On careful bimanual examination with one hand upon the abdomen and two fingers of the other hand in the vagina, the firm, hard cervix is felt, while above it is the elastic body of the uterus, and between the two the site of the future lower uterine segment is felt as a soft compressible area. Occasionally the change in consistence



FIG. 186.—PENDULOUS ABDOMEN OF A MULTIPAROUS WOMAN WITH NORMAL PELVIS.



in this location is so marked that no connection between the cervix and body appears to exist, and in not a few instances inexperienced observers have mistaken the cervix for a small uterus, and the softened body for a tumor of the tubes or ovaries.

This sign, first described by Reini in 1884, was verified later by Sonntag and others. Its value is now universally admitted, and I consider it the most valuable sign of early pregnancy. Its production probably depends upon the forcing of the part of the ovum occupying the lower uterine segment into the upper part of the body of the uterus, so that the empty and softened lower uterine segment can then be readily compressed between



FIG. 187.—METHOD OF DETECTING HEGAR'S SIGN.

the fingers. Fig. 187 gives a good idea of the sensation to be obtained on bimanual examination; and Figs. 188 and 189 show the condition of the uterus which makes it possible. This sign is not, however, absolutely characteristic, as it was definitely present in one of my patients, in whom an abdominal section for the removal of an ovarian cyst revealed a non-pregnant uterus, whose walls were thickened and softened in some unknown manner.

Macdonald in 1908 directed attention to a modification of Hegar's sign, which he claims will make possible the diagnosis of pregnancy during the course of the first month. It is based upon the exaggerated flexibility

of the isthmus of the uterus, and is manifested by the unusual ease with which the fundus and cervix can be brought together on vaginal manipulation.

*Cervix.*—Beginning with the second month of pregnancy, the cervix becomes considerably softened, and in primiparous women the os externum offers to the finger a sensation similar to that obtained by pressing upon the more yielding lips instead of the harder cartilage of the nose, as at other times. In some cases, however, this sign does not become available, as in certain inflammatory conditions, as well as in carcinoma, the cervix may remain firm and hard throughout the entire duration of pregnancy.

*Intermittent Contractions of the Uterus.*—From the first weeks on,

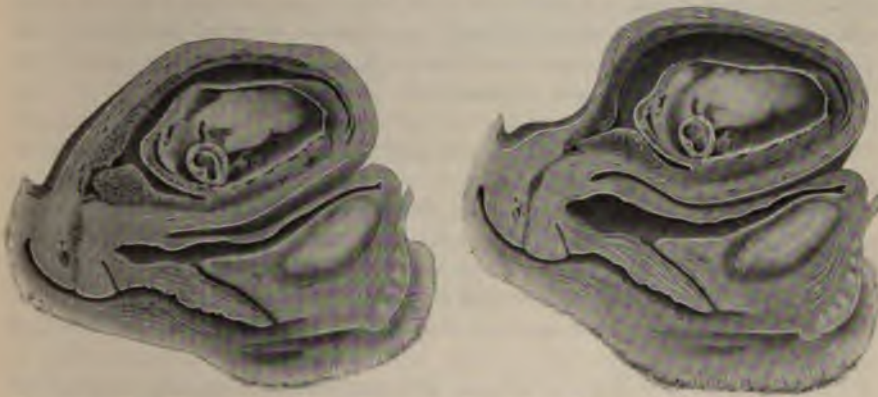


FIG. 188.—TEN WEEKS' PREGNANT UTERUS (Pidard).  $\times \frac{1}{2}$ .

FIG. 189.—SHOWING MODE OF PRODUCTION OF HEGAR'S SIGN.

at intervals of from five to ten minutes, the pregnant uterus undergoes painless contractions, which in the early months can be appreciated by bimanual examination, and later by the hand upon the abdomen, when the previously relaxed organ is felt to become firm and hard, remaining so for a few moments, and then returning to its original condition. Attention was first called to this phenomenon by Braxton Hicks, and the sign has since been known by his name. It is not, however, infallible, as similar contractions are sometimes observed in hæmatometra, and occasionally in cases of soft myomata.

Whenever one or several of these probable signs of pregnancy are detected the evidence becomes very strong. Nevertheless, if there is any possibility of wronging our patient we are not justified in making a positive assertion, even though we may feel morally sure of our diagnosis.

**Presumptive Signs of Pregnancy.**—The presumptive evidences of pregnancy are afforded in great part by subjective symptoms, which may be appreciated by the patient herself. These consist in (1) cessation of the menses, (2) changes in the breasts, (3) morning sickness, (4) quickening, (5) discoloration of the mucous membranes, (6) abnormalities in pigmentation, (7) disturbances in urination, (8) mental and emotional changes, and (9) changes in the blood serum.



*Cessation of the Menses.*—Most important is the cessation of the menstrual flow. In women exposed to the possibility of pregnancy, and whose menses have previously been regular, a sudden cessation is a most characteristic sign; and from it alone the majority of married women do not hesitate to diagnose their condition. But in patients presenting an irregular menstrual history this symptom does not possess the same diagnostic value, as we know that certain diseases may give rise to amenorrhœa of many months' duration, in the course of which conception occasionally occurs.

Furthermore, a single menstrual period may be missed by women who fear the possibility of pregnancy. On the other hand, false statements are often made, and a patient who has missed one or more periods may complain of profuse uterine hæmorrhage, in the hope of misleading the physician and inducing him to introduce a sound or even to curette the uterus, and thereby provoke an abortion.

In not a few instances menstruation may appear once after the commencement of pregnancy, though the flow is usually less profuse than at other times. In many of these cases it is probable that conception has occurred shortly before the period. Only very rarely, however, does the menstrual flow appear more than once, and, although its regular recurrence is theoretically possible until the decidua vera and capsularis fuse together, yet it should always arouse suspicion as to the existence of disease of the endometrium, carcinoma of the cervix, or some other pathological condition.

One occasionally hears of women who menstruate regularly throughout pregnancy, but the majority of these accounts are apocryphal, or else the condition is associated with uterine disease. At the same time it must be admitted that very exceptionally authentic cases are observed, and in one of my patients the most careful examination revealed no other source for the hæmorrhage. Such an occurrence, however, should never be taken for granted, and all other possibilities must be carefully excluded.

*Changes in the Breasts.*—In the chapter upon the Physiology of Pregnancy reference has already been made to the changes which occur in the breasts. Generally speaking, in primiparæ these are quite characteristic, but are of less value in multiparæ, since the breasts of the latter not infrequently contain a small amount of milk or colostrum for months, or even for years, following the last labor. Occasionally, changes in the breasts similar to those produced by pregnancy may be observed in women suffering with ovarian or uterine tumors. Nor is the possibility of their occurrence excluded in instances of spurious or imaginary pregnancy.

*Nausea and Vomiting.*—The establishment of pregnancy is frequently manifested by disturbances of the digestive system, more particularly manifested by nausea and vomiting. This "*morning sickness*," as the name implies, usually comes on in the earlier part of the day, and passes off in a few hours, although it occasionally persists longer or may occur at other times. It usually appears about the end of the first month, and disappears spontaneously after six or eight weeks, although some patients suffer from it for a much longer period.

There is considerable discrepancy of opinion as to the frequency with which these symptoms are observed, but my experience is that probably one-half of all pregnant women suffer from them to a greater or lesser degree. In many it amounts to nothing more than an occasional sensation of nausea; others have considerable vomiting, while in rare instances the nausea and vomiting may be so persistent and constant as to interfere seriously with nutrition. Occasionally, similar symptoms result from nervousness or from the fear of an illegitimate pregnancy, as well as in certain cases of pseudocyesis.

*Quickening.*—About the eighteenth or twentieth week the woman becomes conscious of slight, fluttering movements in her abdomen, which gradually increase in intensity. These are usually due to movements of the fœtus, and their first appearance is designated as “quickening” or the perception of life. Occasionally fœtal movements may be perceived as early as the tenth week, while in rare instances they may not be experienced at all.

This sign offers only corroborative evidence of pregnancy, and is of no value unless confirmed by the hand of the physician, as in many nervous women similar sensations are experienced in its absence.

*Discoloration of the Mucous Membrane of Vagina and Vulva.*—Under the influence of pregnancy the margins of the vaginal opening and the lower portion of the anterior vaginal wall frequently take on a somewhat dark bluish or purplish, congested appearance. Attention was first called to this condition by Jacquemier and Kluge, but particular stress was laid upon its significance by Dr. James R. Chadwick, of Boston, so that in this country it is known as *Chadwick's sign*. Its presence supplies valuable presumptive evidence, but is not conclusive, as it may likewise be observed in any condition leading to intense congestion of the pelvic organs.

*Pigmentation of the Skin and Abdominal Striæ.*—These manifestations, which have already been referred to in the chapter upon the physiology of pregnancy, are usually observed in this condition, but are not absolutely characteristic of it, as they are sometimes associated with tumors of other origin.

*Urinary Disturbances.*—In the early weeks of pregnancy the enlarging uterus, by exerting pressure on the bladder, causes a desire for frequent micturition. This is most marked in the first few months, and gradually passes off as the uterus rises up into the abdomen, to reappear when the head descends into the pelvis a few weeks before term.

*Cravings—Mental and Emotional Changes.*—Occasionally the appetite of the pregnant woman becomes very capricious, and she may evince an almost unconquerable desire for peculiar and sometimes revolting articles of food. I recall one patient who subsisted almost exclusively upon deviled crabs throughout the entire duration of pregnancy, and another who could retain nothing for the first four months except broiled lobster and Bass's ale.

We have already referred to the mental and emotional changes which sometimes characterize pregnancy, and occasionally we meet with women who diagnose their condition mainly from the occurrence of changes in



their own temperament with which they have become familiar in previous pregnancies.

*Changes in the Blood Serum.*—In the preceding chapter reference was made to changes in the antitryptic titer, and in the adrenalin and cholesterol content of the maternal serum which are said to characterize pregnancy; while Fieux and Mauriac believe that in the early months it also contains an antibody whose presence can be revealed by the deviation of complement reaction, when young chorionic villi are used as antigen. The demonstration of such changes, however, is too complicated for ordinary clinical purposes. On the other hand, if the claims of Neumann and Hermann are substantiated, we may have at our disposal a valuable aid to diagnosis, which is attributable to an increase in the amount of lipoids present in the serum in the latter months of pregnancy. This reaction consists in adding a drop of distilled water to a filtered alcoholic extract prepared from one cubic centimeter of blood. The fluid becomes turbid if pregnancy exists, while it remains clear and transparent in non-pregnant women.

**Synopsis of Signs and Symptoms of Pregnancy.**—For convenience of reference, we give a synopsis of the signs and symptoms of pregnancy, dividing them into three groups, according as they occur in the first three months, in the fourth and fifth months, or in the last five months of pregnancy.

In the first period the symptoms are: (*a*) cessation of the menses; (*b*) changes in the breasts; (*c*) morning sickness; (*d*) urinary disturbances. The signs are: (1) enlargement and softening of the body of the uterus and increased antelexion; (2) changes in the consistency of the body of the uterus; (3) Hegar's sign; (4) changes in the cervix; (5) Chadwick's sign; (6) the abdomen is not prominent, the navel is depressed; (7) auscultation is negative.

Second period. Symptoms: (*a*) menses still absent; (*b*) more marked changes in the breasts; (*c*) disappearance or subsidence of gastric and urinary disturbances; (*d*) quickening. Signs: (1) the fundus is felt several fingers above the symphysis at the fourth month, and midway between the symphysis and umbilicus at the fifth month; (2) the cervix is soft; (3) ballottement is obtainable; (4) intermittent uterine contractions are recognizable; (5) at the very end of the period the foetal heart sounds can be distinguished.

Third period. Symptoms: (*a*) menses still absent; (*b*) changes in the breasts more marked; (*c*) in the last month frequent urination reappears, often with neuralgic pains in the lower extremities. Signs: (1) progressive enlargement of the abdomen; (2) umbilicus smooth and later protruding; (3) the foetal heart can be heard; (4) the different parts of the child can be palpated; (5) foetal movements are perceptible.

In the first period the diagnosis is usually very probable, but never absolute; in the second, very rarely doubtful, and in the third absolute.

**Differential Diagnosis of Pregnancy.**—The pregnant uterus is often mistaken for other tumors occupying the pelvic or abdominal cavities, and *vice versa*, though, as a rule, the former mistake is more frequently

made. The early periods of pregnancy may be simulated by enlargement of the uterus due to interstitial or submucous myomata, sarcomata, hæmatometra, and conditions resulting from inflammatory disturbances. As a rule, the uterus under these circumstances is harder and firmer than in pregnancy, and does not present its characteristic elastic or boggy consistency. Moreover, except in hæmatometra, such conditions are not attended by cessation of the menses. If, however, there is any possibility of a mistake, a delay of a few weeks will usually clear up the diagnosis.

The pregnant uterus is occasionally mistaken for small ovarian or tubal tumors, though this error should rarely occur if the patient be carefully examined bimanually and the pelvic contents isolated, if necessary under an anæsthetic. As the tumor becomes larger and rises up into the abdomen, other points become available for differential diagnosis, notably the intermittent contractions of Braxton Hicks and the positive signs of pregnancy.

The diagnosis of pregnancy in a myomatous uterus often presents serious difficulties, and for a time may be impossible. But a short delay will show a more rapid increase in the size of the tumor than is consistent with the existence of an uncomplicated myoma, and variations in the consistency of different parts should also serve to direct one's attention to the pregnant condition.

Occasionally, an ovarian cystoma may be complicated by pregnancy. In the early stages the diagnosis, as a rule, can be easily made, as careful bimanual examination should enable one to differentiate between the two tumors; but in the later months it may become extremely difficult and sometimes impossible, owing to the increased distention of the abdomen. Furthermore, if the positive signs of pregnancy cannot be elicited, its existence is usually overlooked and a simple cystoma diagnosed; whereas, if the heart sounds are heard, the cystoma may escape recognition and the excessive abdominal enlargement be attributed to a hydramnios.

In rare instances hypertrophy of the supravaginal portion of the cervix may seriously increase the difficulties of diagnosis, as the enlarged and hard cervix may be mistaken for the entire uterus, the soft and elastic body being either overlooked or regarded as a tumor of the uterine appendages. Careful bimanual examination under anæsthesia should do away with the possibility of this error.

Irregular development of the pregnant uterus, associated with a sacculatation of its anterior or posterior wall, may seriously complicate the diagnosis, especially if the fœtus be dead; as even after the most careful examination the existence of pregnancy may remain unrecognized and the sacculatation be mistaken for an ovarian cyst. This is especially apt to occur when the pregnancy develops in the posterior wall, as in such cases the anterior wall may remain practically unchanged, and when, under anæsthesia, one can feel the fundus with both tubes extending from it, it is almost a pardonable error to conclude that the fluctuant tumor lying posterior to it is an ovarian cyst.

**Spurious Pregnancy.**—Imaginary pregnancy, or *pseudocyesis*, is a condition with which almost every practitioner, sooner or later, will meet. It is usually observed in patients nearing the menopause, or in young women



who intensely desire offspring. Such patients may present all the subjective symptoms of pregnancy, associated with a marked increase in the size of the abdomen, which is due either to an abnormal and rapid deposition of fat or to the existence of tympanites and occasionally of ascites. When it occurs in the earlier years of life the menses do not, as a rule, disappear, but may present certain abnormalities which the patient considers are due to her supposed condition.

In many instances the woman may imagine that she detects foetal movements, which are sometimes so violent as to make her fearful that they

may be visible to onlookers. I recall a patient who imagined herself in the last month of pregnancy, and who, while talking to me, exclaimed at the violence of the movements, but on examination I found that her uterus was normal in size, and that her enlarged abdomen was due to a rapidly increasing deposit of fat.

The supposed foetal movements usually result from contractions of the intestines or the muscles of the abdominal wall, and occasionally are so marked as to deceive even physicians. Careful examination of the patient usually enables one to arrive at a correct diagnosis without great difficulty, as the small uterus can be demonstrated on bimanual examination, made, if necessary, under



FIG. 190.—ABDOMINAL ENLARGEMENT DUE TO FAT, THE PATIENT IMAGINING HERSELF TO BE IN THE LAST MONTH OF PREGNANCY.

anæsthesia. The greatest difficulty in these cases is to persuade the patient as to the correctness of the diagnosis. Bichebois has pointed out that insane women frequently suffer from the delusion that they are pregnant, and persist in such a belief for years.

**Distinction between First and Subsequent Pregnancies.**—Occasionally it is a matter of practical importance to decide whether a patient is pregnant for the first time or has previously borne children. Ordinarily child-bearing leaves indelible traces behind it, which are readily appreciated; but very exceptionally such signs are lacking, as in a case reported by Budin. (See Fig. 36.) Again, in very rare instances, all the signs indicating a previous labor may follow the removal of a large tumor through the vagina.

In a pregnant woman who has never borne children the abdomen is usually tense and firm, and the uterus is felt through it only with difficulty. The characteristic pinkish bluish striæ and the distinctive changes

in the breasts are readily observed. The labia majora are usually in close apposition, the frenulum is intact, and the hymen torn in several places. The vagina is usually narrow and marked by well-developed rugæ. The cervix is softened, but does not usually admit the tip of the finger until the very end of pregnancy; and during the last four to six weeks of pregnancy the presenting part is found engaged in the superior strait, unless some disproportion exists.

In multiparous women, on the other hand, the abdominal walls are usually lax, flabby, and frequently pendulous, and the uterus is readily palpated through them. In addition to the pinkish striae due to the present condition, the silvery cicatrices of past pregnancies may also be noted. The breasts are usually not as firm as in the first pregnancy, and frequently present striae similar to those observed on the abdomen. The vulva is usually more or less gaping, the frenulum has disappeared, and the hymen is replaced by the *carunculæ myrtiformes*. The external os, even in the early months of pregnancy, usually shows signs of laceration, and at a little later period readily admits the tip of the finger, which can be carried up to the internal os. Furthermore, in the majority of cases the presenting part does not engage in the superior strait until the onset of labor.

**Diagnosis of the Life or Death of the Fœtus.**—Generally speaking, the fœtus should be considered to be alive unless definite evidence to the contrary can be adduced. In the early months of pregnancy the diagnosis of fœtal death offers considerable difficulty, and can be made only after repeated examinations have demonstrated that the uterus has remained stationary in size for a number of weeks.

In the later months of pregnancy, the disappearance of fœtal movements usually directs the attention of the patient to this possibility; moreover, she may suffer from ill-defined sensations, such as chilliness, languor, a sensation of weight in the abdomen, and perhaps a foul taste in the mouth. Careful investigation shows that the uterus does not correspond in size with the estimated duration of pregnancy, or even perhaps has become smaller than previously; while at the same time retrogressive changes have occurred in the breasts, which have become soft and flabby. The diagnosis, however, can be considered absolute only after repeated examinations, when in addition to the signs just mentioned one has failed to hear the fœtal heart or perceive the movements of the child.

Positive information is occasionally afforded by palpating the macerated skull through the partially dilated cervix; whenever one can feel that the bones of the head are loose and present a sensation as if they were contained in a flabby bag, the diagnosis can be made at once without hesitation.

**Duration of Pregnancy.**—As we have no means of ascertaining the exact date at which fertilization occurs, it is apparent that absolutely accurate statements as to the duration of pregnancy cannot be made. Conception may occur at any time, although the researches of Fraenkel indicate that it is most usual somewhat after the middle of the inter-menstrual period. That no absolute rule exists as to the time of ovulation is



shown by the examination of ovaries removed at operation, as well as by the experience of embryologists that it is not unusual for young embryos, which should be of the same age when calculated from the last menstrual period, to present marked variations in development.

Usually labor ensues about two hundred and eighty days (ten lunar months) after the first day of the last menstrual period, so that the actual duration of pregnancy is two hundred and seventy-five days, or less. This rule, however, is subject to many exceptions, as apparently well-developed children may be born as early as the two hundred and fortieth and as late as the three hundred and twentieth day after the last menstrual period.

Every one practicing obstetrics occasionally meets with cases in which the patient believes that she has passed a month beyond term; or, in other words, that the pregnancy has lasted eleven lunar months. This belief, however, is usually erroneous, as in the majority of such cases conception did not occur until just before the first period which was missed. Exceptionally, however, pregnancy may last for an abnormally long period, and I recall a patient who on two occasions did not fall into labor until considerably over eleven months after the last period. In both instances the children weighed over 12 pounds, were 55 centimeters in length, and presented markedly increased thoracic measurements.

Winckel, after carefully studying his material, states that about one-seventh of all children weighing 4,000 grams or more ( $8\frac{1}{2}$  pounds) have been carried for three hundred and two days or longer after conception, and that in very exceptional instances pregnancy may last as long as three hundred and thirty-six days. Starcke, and Blau and Christofolletti arrived at similar conclusions.

Even when we know the date of the coitus from which the pregnancy has resulted, we are in no better position to estimate the actual length of pregnancy, inasmuch as Löwenhardt has pointed out that two women may have fruitful coitus on the same day, and yet the date of their deliveries may vary markedly. Ahlfeld analyzed 425 cases in which the date of coitus was supposed to be known, and found the average duration of pregnancy to be 269.91 days; but individual cases in the series varied from between two hundred and thirty-one to three hundred and twenty-nine days.

Similar differences are reported by veterinarians, who usually date the beginning of pregnancy from a single coitus. According to Franck-Albrecht-Göring, the average duration of pregnancy in the mare is three hundred and sixty-six days, but in a large series of cases individual variations between three hundred and seven and four hundred and twelve days were noted. In the cow the normal duration is placed at two hundred and eighty days, with extremes of two hundred and forty and three hundred and eleven days. Again, as Mme. Laurié has shown, the duration of pregnancy also depends upon the extent to which the patient can spare herself in the last three months of pregnancy. This observer found that it was twenty days longer in 1,550 women who lived comfortably in a hospital for several months prior to delivery than in the same number of women who entered at the onset of labor. Her figures, then, go to show that hard

work in poorly nourished women predisposes somewhat to the premature ending of pregnancy.

In view of these facts we must conclude that the duration of pregnancy varies within certain limits, which probably depend upon individual peculiarities, just as happens in the case of mares and cows, and that it not infrequently exceeds two hundred and eighty days from the last menstrual period, when large children are developed, which are frequently delivered only after great difficulty. Accordingly, whenever the menstrual history of the patient indicates that she has passed much beyond the tenth and is approaching the eleventh lunar month, the size of the child should be carefully determined and we should consider the propriety of the induction of labor, if it is found to be larger than usual.

**Estimation of the Probable Date of Confinement.**—Unfortunately for the comfort of the patient, as well as of the physician, we possess no reliable means of estimating the exact date, but are obliged to content ourselves with the method proposed by Naegele, which is based upon the belief that labor occurs two hundred and eighty days from the beginning of the last menstrual period. The calculation is readily made by adding seven days to the date at which the last menstrual period first appeared, and then counting back three months. For example, if the last period began on January 10th, we add seven days, making January 17, and count back three months, thus fixing upon October 17th as the probable date of confinement.

In a small number of cases the patient will be confined on the precise day estimated, and in the great majority of cases within a few days of it; but occasionally a period of several weeks may elapse before labor occurs. This marked difference is probably due to the fact that in the one case conception had occurred soon after the last period, and in the latter just before the first period which was missed. Accordingly, the physician should hesitate to predict a definite day for the confinement, and should always allow a margin of two to three weeks in his calculations. I have made the interesting observation that in two-thirds of the young women who miss the first menstrual period after marriage, a fully developed child is born 280 days from the beginning of the last menstrual period. As this is less than nine calendar months after the date of marriage, it would indicate that pregnancy does not always last as long as ten lunar months.

Löwenhardt believed that the duration of pregnancy was ten menstrual periods, and considered the labor as likely to occur when the tenth period following conception fell due, and Schatz has adduced considerable evidence along similar lines. Accordingly, in patients menstruating at intervals of twenty-six or thirty days, for example, the duration of pregnancy would be two hundred and sixty or three hundred days respectively. In the long run, however, this method of calculation does not give more accurate results than that of Naegele.

Occasionally the patient believes that she can date her pregnancy from a single coitus, and prefers to estimate the approaching date of confinement from that rather than from the beginning of the last period. This method is subject to quite as great an error as if calculated from the latter date,



as we have no means of ascertaining how long the spermatozoa may remain in the genital tract before conception occurs.

Frequent attempts have been made to estimate the date of confinement by adding twenty or twenty-one weeks to the date upon which the patient first perceived foetal movements. This method is founded on the belief that

quickening is first experienced at the eighteenth or twentieth week of pregnancy. Unfortunately, this assumption is erroneous, as the symptom not infrequently occurs at a much earlier period, and sometimes not until considerably later.

In not a few instances, especially in nursing women, conception may take place during a period of amenorrhœa, and the patient is often surprised by the enlargement of her abdomen or by the perception of foetal movements; while occasionally the first intimation that she is pregnant is given by the fact that her milk, which has previously



FIG. 191.—RELATIVE HEIGHT OF THE FUNDUS AT THE VARIOUS WEEKS OF PREGNANCY.

agreed very well with the infant, suddenly becomes indigestible. Under such circumstances, the usual methods of calculation are of no value, and we have to depend upon other means, which, unfortunately, are extremely unsatisfactory.

In such cases our calculations are based upon the enlargement of the abdomen and the height to which the fundus of the uterus has risen. Generally speaking, we find that the fundus at the fourth month is several fingers'-breadths above the symphysis pubis; at the fifth month midway between it and the umbilicus; at the sixth month at the level of the umbilicus; at the seventh month three fingers'-breadths above the umbilicus; at the eighth month an equal distance above its position at the seventh month; at the ninth month just below the xiphoid; whereas in the last month, particularly in primiparous women, it sinks downward and assumes almost the position it occupied at the eighth month.

This method, however, gives only approximate results, as the position of the umbilicus is subject to marked variations, while the distention of

the uterus is dependent not only upon the size of the child, but also upon the quantity of amniotic fluid. According to Spiegelberg, the situation of the umbilicus varies from 13 to 28 centimeters above the symphysis, so that there may be a difference of 6 inches in its position. On this account it has been thought preferable by some authors to estimate the distance of the fundus from the symphysis pubis with a tape measure, the average results obtained by Spiegelberg being as follows:

|                        |                         |   |
|------------------------|-------------------------|---|
| 22d to 28th week ..... | 24 to 24.5 centimeters. |   |
| 28th week .....        | 26.7                    | " |
| 30th " .....           | 28.4                    | " |
| 32d " .....            | 29.5 to 30              | " |
| 34th " .....           | 31                      | " |
| 36th " .....           | 32                      | " |
| 38th " .....           | 33.1                    | " |
| 40th " .....           | 33.7                    | " |

These measurements, however, are subject to considerable variations, as they are dependent not only upon the size of the foetus contained within the uterus, but also upon the degree of distention of the abdominal contents. Nevertheless, in cases in which we possess no other data, they occasionally afford us information of very considerable value.

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## CHAPTER VIII

### THE MANAGEMENT OF NORMAL PREGNANCY

From a biological point of view, pregnancy and labor represent the highest functions of the female reproductive system, and *a priori* should be considered as normal processes. But when we recall the manifold changes which occur in the maternal organism, it is apparent that the border-line between health and disease is less distinctly marked during gestation than at other times, and derangements, so slight as to be of but little consequence under ordinary circumstances, may readily give rise to pathological conditions which seriously threaten the life of the mother or the child, or both.

It accordingly becomes necessary to keep pregnant patients under strict supervision, and to be constantly on the alert for the appearance of untoward symptoms. The services of an obstetrician should be engaged some months before the expected date of confinement, so that upon him devolves the duty of advising the patient as to her mode of life during the intervening months. Any one who has a moderately extensive obstetrical practice can save himself no little trouble by having cards printed, which briefly outline what the patient is expected to do, and in which are enumerated the various abnormal symptoms which may occur and to which the physician's attention should be immediately called. I give below (page 210) the card which I give my patients, and in the chapter on the conduct of labor the one prepared for the nurse.

Unless it be found upon inquiry that the patient has been leading an ill-ordered existence, very little change should be made in her mode of living, and she should be encouraged to go on much as usual, care being taken that she receives the proper amount of exercise, amusement, and diversion. It is the duty of the physician to gain the confidence of his patient and encourage her to come to him whenever anything occurs to worry her, instead of taking advice from her women friends. A woman in her first pregnancy generally stands in need of a certain amount of reassurance with regard to the dangers of parturition, and the knowledge that she is in the hands of a competent and careful physician will contribute largely to her peace of mind as well as to her physical well-being.

**Exercise.**—During normal pregnancy the woman should be encouraged to take as much outdoor exercise as possible, though in individual cases it is often difficult to specify the exact amount—a safe rule being to instruct her to desist while still feeling that she could do more without tiring her-



self. Exercise should consist of walking, driving or motoring over good roads, but the ordinary sports should be interdicted, though sea-bathing in many instances is very beneficial. When for various reasons outdoor exercise cannot be taken, massage in the hands of a skillful person is to be recommended. In the later months long journeys should not be undertaken unless absolutely necessary, and driving over rough roads should be avoided.

**Diet.**—The diet should be abundant and nourishing, and ordinarily the patient should be allowed to continue her usual customs, but should be warned to abstain from very highly seasoned or indigestible articles of food. In slight degrees of pelvic contraction, or in patients who have previously given birth to excessively heavy children, a restricted diet may be advisable during the last two or three months, as I have already shown that the larger size of the children in the well-to-do classes is in great part attributable to the life of ease and the abundance of food enjoyed by the mothers. Prochownick pointed out, and his experience has been confirmed by Reeb and Noel Paton, that a diet poor in carbohydrates and fluids exerts considerable influence in lessening the weight of the child without otherwise affecting it, and in not a few cases these precautionary measures may obviate a difficult delivery, or even do away with the necessity for the induction of premature labor. These conclusions stand in marked contrast to those usually held by the laity, who erroneously believe that abstinence from proteid food is the essential point.

**The Bowels.**—During pregnancy the enlarged uterus sometimes interferes with the normal intestinal peristalsis, and gives rise to more or less marked constipation. Under such circumstances care should be taken that the bowels are moved daily, which is best accomplished by the administration of cascara sagrada or pills containing aloin, belladonna, and strychnine. The use of active cathartics is inadvisable, unless their employment be specially indicated in certain morbid conditions. In some instances, however, the judicious administration of an occasional dose of calomel is followed by marked beneficial results.

**Clothing.**—The physician is frequently asked concerning the clothing which is best adapted to the pregnant state, and especially whether corsets should be worn or not. Generally speaking, the clothing should be loose and so arranged as to exert as little pressure upon the waist as possible; and in the later months of pregnancy, at least, the ordinary corset should be replaced by a loosely fitting corset-waist or by one of the specially designed "maternity" corsets. In multiparous women, when the abdomen is markedly relaxed from previous childbearing, the wearing of an abdominal support of elastic material or an ordinary Scultetus bandage adds materially to their comfort. When varicose veins of the extremities are present the legs should be bandaged or encased in elastic stockings, and when large varices exist about the vulva the patient should be cautioned concerning the possibility of their rupture.

**Sexual Intercourse.**—In healthy persons sexual intercourse in moderation usually does no harm, as long as the abdominal enlargement is not too great to make it inconvenient for the patient. But where there is a

tendency to abortion it should be strictly interdicted. It should also be positively forbidden in the last month of pregnancy, as I know of at least one case in which a severe puerperal infection has followed coitus during that period. In this instance the patient, who had not been examined internally, had a severe streptococcus infection in the puerperium, and, upon searching for its cause, it was found that she had had sexual intercourse just before the onset of the first stage of labor.

**The Breasts.**—In the last three months of pregnancy attention should be devoted to the condition of the breasts, and more particularly to the nipples, as by appropriate preliminary treatment nursing may be rendered easier, and the occurrence of fissures and the consequent danger of mammary infection in great part prevented. For this purpose the patient, during the last two months, should bathe her nipples night and morning with a lotion which tends to make the skin covering them more resistant. A saturated solution of borax or boric acid in 50 per cent. alcohol will answer the purpose very well. Where the nipples are small it is advisable to attempt to lengthen them by making a few tractions upon them night and morning; and where they are but slightly prominent good results sometimes following the wearing of a wooden nipple shield (Fig. 192) for a few hours of each day, which is held in place by adhesive strips. I know of no means, however, by which deeply retracted nipples can be made serviceable.

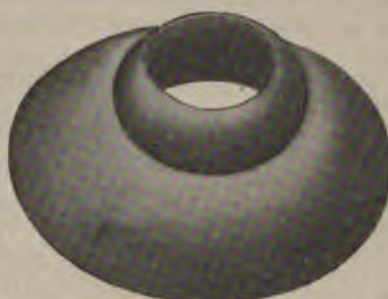


FIG. 192.—WOODEN NIPPLE SHIELD.

**Urine.**—Owing to the frequency of renal disturbances and the serious consequences which frequently result from them, the urine should be carefully examined at regular intervals: once a month for the first seven months, and at least twice a month, and preferably every week, during the last three months of pregnancy. It is advisable that the physician should not only arrange definite periods at which specimens are to be sent, but that he should himself make a note of these dates, so that, in case the patient becomes careless in the matter and neglects to carry out his directions, he can remind her. Of course it may be very plausibly argued that the patient incurs the main risk from such neglect; but the prevention of a single death from eclampsia will amply repay the conscientious physician for much self-imposed labor.

The urine should be examined not only for the presence of albumin and sugar, but also microscopically. If albumin is detected in any quantity, or the patient presents symptoms indicative of toxæmia, a twenty-four-hour specimen should be saved and sent to a competent chemist for the determination of the total amount of nitrogen and of the nitrogenous partition. Where this is not feasible, at least the total amount of urea and albumin should be estimated by the physician by means of the Doremus ureometer and Esbach's albuminometer. (See Chapter XXVI.)



In addition to giving the patient the advice above mentioned, the physician should also impress upon her the importance of informing him at once in case any of the following symptoms be noted; a scanty flow of urine, persistent headache, disturbances of vision, swelling of the feet and face, any loss of blood no matter how slight, and persistent constipation. In the majority of cases these symptoms are of secondary importance, but occasionally they serve to warn us of the imminence of some serious affection which may be cured or alleviated by appropriate treatment.

PRINTED DIRECTIONS FOR PATIENTS DURING PREGNANCY

(a) Take as much outdoor exercise as possible, but guard against over-tiring yourself.

(b) See that the bowels are moved daily.

(c) On the first day of each month send me an 8-oz. bottle of mixed (night and morning) urine; and for the two months preceding the expected date of confinement send it on the first and fifteenth days of the month. Be sure to send your name with the specimen.

(d) From the sixth month onward bathe the nipples night and morning with a solution prepared as follows: Fill a tumbler with equal parts of alcohol and water and add to it a tablespoonful of borax. Keep the solution in a bottle and apply it by means of absorbent cotton.

(e) Six weeks before the expected date of confinement buy my "Confinement Outfit." In this is included everything which will be needed by the nurse and myself, except baby's clothes. At the same provide two pieces of rubber sheeting,  $\frac{3}{4} \times 1$  yard, and  $1 \times 2$  yards respectively; a bed pan, two small round agate basins, a 2-quart fountain syringe and 15 yards of gauze and two pieces of cotton batting for making bed pads, or 4 ready-made sanitary bed pads.

(f) Send for nurse as soon as labor pains commence, and, unless some emergency arises, let her use her judgment in sending for me.

(g) Notify me at once if any of the following symptoms be observed at any time during pregnancy:

1. Scanty urine.
2. Persistent headache.
3. Disturbance of vision.
4. Swelling of feet or face.
5. Loss of blood.
6. Persistent constipation.
7. And also when you feel that anything is not as it should be.

(h) I shall call to see you five or six weeks before you expect to be sick in order to ascertain your condition and to give you any desired advice.

**Preliminary Examination.**—Four to six weeks before the expected date of confinement a careful examination is indispensable, and to neglect in this respect can be attributed the deaths of untold numbers of women and children. Usually this can be made much more conveniently with the patient in her own home and in bed than at the physician's office. At

this time the general condition should be carefully noted, particular attention being also paid to the measurements of the pelvis, as well as to the size, presentation and position of the child.

Unless the physician fully appreciates the importance of this examination, and has learned to look upon the making of it as a bounden duty, he may sometimes be deterred by feeling that it is repugnant to the patient, and that she may object to it or even refuse it. My experience, however, has always been that a few words of kindly explanation soon smooth away all such difficulties; and when, as happens fortunately in the vast majority of cases, after the examination we can reassure the woman as to the prospects of a simple and safe delivery, she will feel amply repaid for any inconvenience to which she may have been subjected. On the other hand, if any abnormality is present, it is essential for the physician to know of its existence in advance, and, even although he may not always deem it advisable to communicate his conclusions to the patient herself, he will generally do well to inform the husband or some other responsible member of her family of the existing condition. If, however, it should happen that, despite the exercise of the greatest tact on the part of the physician, and his insistence that such an examination is a necessity for her own sake, the patient persists in her refusal, the former has no alternative but to decline absolutely to attend the case.

The first point in the preliminary examination is careful *pelvic mensuration*, and Dohrn has well said that the physician who neglects pelvimetry is comparable to one who attempts to treat pulmonary diseases without the aid of auscultation and percussion. In the majority of instances the usual external measurements, including palpation of the pubic arch, are quite sufficient, unless they indicate the possibility of some pelvic abnormality. Generally speaking, provided the head is deeply engaged, if the measurements between the iliac spines and crests bear an approximately normal relation to one another, internal pelvimetry is not necessary unless Baudelocque's diameter is 18.5 centimeters or less. But even if the latter diameter is normal the pelvis should be measured internally, and if necessary under anæsthesia, whenever the head does not engage during the last month of a first pregnancy, or in any patient in whom the pelvic outlet is contracted, or who limps or presents signs of deformity of the spine or legs. Failure to observe this precaution may occasionally lead to most unpleasant surprises at the time of labor. If an abnormality be detected at this examination the physician is both forewarned and forearmed, and in extreme cases he will be prepared at the proper time to suggest the induction of premature labor, or to keep the patient within reach of a competent operator who will be ready to perform Cæsarean section at the time of election.

After measuring the pelvis, the abdomen should be carefully examined, the duration of pregnancy estimated, and the existence of any abnormality, as hydramnios or twins, noted; after which the size, position and presentation of the child should be determined by *external palpation*, according to the rules which will be given later. An internal examination is necessary only in those cases in which palpation gives uncertain or unsatisfactory



results, or when the head is not engaged in primiparous women. The physician who knows how to utilize all the resources of external palpation and manipulation will find that by these means he can usually not only recognize normal and abnormal presentations in advance, but can also convert breech, transverse, or face presentations into those of the vertex.

When *vaginal exploration* is necessary at the preliminary examination, if undertaken prior to the end of the ninth lunar month, rigorous hand disinfection is not necessary, and the physician may content himself with the use of a nail-brush, soap, and hot water. In the last month of pregnancy, however, the hands should be as carefully disinfected as at the time of delivery, for we have no means of knowing exactly when labor may supervene, and our neglect may occasionally give rise to puerperal infection.

The various abnormalities occurring in the course of pregnancy will be considered in a separate chapter.

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## CHAPTER IX

### PRESENTATION AND POSITION OF THE FÆTUS—METHODS OF DIAGNOSIS

#### PRESENTATION AND POSITION OF FÆTUS

Irrespective of the relation which it may bear to the mother, the fœtus in the later months of pregnancy assumes a characteristic posture, which is described as its *attitude* or *habitus*; and, as a general rule, it may be said to form an ovoid mass, which roughly corresponds with the shape of the uterine cavity. Thus, it is usually folded or bent upon itself in such a way that the back becomes markedly convex, the head is sharply flexed so that the chin is almost in contact with the breast, the thighs are flexed over the abdomen, the legs are bent at the knee-joints, and the arches of the feet rest upon the anterior surfaces of the legs. The arms are usually crossed over the thorax or are parallel to the sides, while the umbilical cord lies in the space between them and the lower extremities.

This attitude is usually retained throughout pregnancy, though it is frequently modified somewhat by the movements of the extremities, and occasionally the head may become deflected, when a totally different posture is assumed. The characteristic attitude results partly from the mode of growth of the fœtus, and partly from a process of accommodation between it and the outlines of the uterine cavity.

**Presentation.**—By this term is understood the relation which the long axis of the fœtus bears to that of the mother, and we accordingly distinguish between longitudinal and transverse presentations. Occasionally during pregnancy the fœtal may cross the maternal axis at an angle, and thus give rise to oblique presentations; but, as these always become longitudinal or transverse during the course of labor, they are not considered as distinct varieties. *Longitudinal presentations* are by far the most frequent, occurring in from 99 to 99.5 per cent. of all cases.

Considerable confusion has resulted from confounding the term *presentation* and *presenting part*. By the latter we understand the portion of the fœtus which is felt through the cervix on vaginal examination, or which engages at the superior strait. Accordingly, in longitudinal presentations the presenting part may be either the head or the breech, and we speak of *cephalic* or *breech presentations* respectively. When the fœtus lies with its long axis transversely, the shoulder is the presenting part, and we speak of *shoulder presentations*.



Longitudinal presentations are broadly classified as normal, and transverse as abnormal, inasmuch as with the former the child is usually delivered by the unaided efforts of Nature; whereas if the latter persist it cannot be born spontaneously, but always requires the aid of the obstetrician. These abnormal presentations will be considered in a separate chapter.

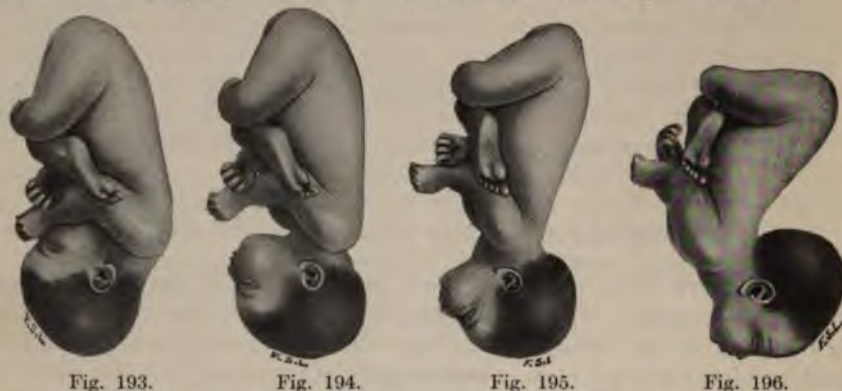


Fig. 193.

Fig. 194.

Fig. 195.

Fig. 196.

FIGS. 193-196.—SHOWING DIFFERENCE IN ATTITUDE OF FÆTUS IN VERTEX, SINCIPUT, BROW, AND FACE PRESENTATIONS.

Cephalic presentations are divided into several groups, according to the relation which the head bears to the body of the child. Usually the head is sharply flexed, so that the chin is in contact with the thorax. Under these circumstances the vertex is the presenting part—*vertex presentation*. More rarely the neck may be over-extended, so that the occiput and back come in contact and the face is felt through the cervix—*face presentation*. Again, the head may assume an intermediate position between the extremes



Fig. 197.

Fig. 198.

Fig. 199.

Fig. 200.

FIGS. 197-200.—SHOWING DIFFERENCE IN ATTITUDE OF FÆTUS IN FRANK BREECH, FULL BREECH, FOOT, AND KNEE PRESENTATIONS.

of flexion and extension, being partially flexed in some cases, when the large fontanelle presents—*sincipital presentation*; or partially extended in other cases, so that the brow becomes the presenting part—*brow presentation*. The last two are not usually classified as distinct varieties, as they

are usually transient, and become converted into vertex or face presentations as labor progresses.

When the child presents by its pelvic extremity, the thighs may be flexed and the legs extended over the anterior surface of the body—*frank breech presentation*; again, the thighs may be flexed on the abdomen and the legs upon the thighs—*breech presentation*; or the feet may be the lowest part—*foot or footling presentation*. Occasionally one leg may retain the position which is typical of one of the above-mentioned presentations, while the other foot or knee may present—*incomplete foot or knee presentation*. As the mechanism of labor, however, is essentially the same in all modifications of pelvic presentations, the several varieties need not be considered separately.

**Position.**—By this term we designate the relation of some arbitrarily chosen portion of the child to the right or left side of the mother. Accordingly, with each presentation we have one or other of two positions—right or left. With us and in France, the occiput, chin, and sacrum are the determining points in vertex, face, and breech presentations respectively; while in Germany the objective point is the child's back.

**Variety.**—Furthermore, for the purpose of still more accurate orientation, we take into consideration the relationship of some given portion of the presenting part to the anterior, transverse, or posterior portion of the mother's pelvis. Thus, as there are two positions, there will be in all six varieties for each presentation. But as the transverse varieties are not persistent, and usually represent only a phase in the mechanism of labor, they need not be taken into account.

**Nomenclature.**—Unfortunately, a universal nomenclature for designating the various presentations and positions has not as yet been agreed upon, and the methods employed vary in different countries and even in different parts of the same country, though of late there has arisen a greater tendency toward uniformity.

In the earlier works upon obstetrics, as in Roesslin's *Rosengarten* (1513), it was believed that the child might assume any imaginable position *in utero*, and the number of presentations and positions was limited only by the ingenuity of the writer. More accurate observation gradually did away with the fanciful forms, but even as late as 1775 Baudelocque distinguished 94 different presentations. Mme. La Chapelle (1821) materially simplified the subject, and the classification which she suggested differs but little from that employed in France to-day, which has been best described by Farabeuf and Varnier.

According to the French method, vertex, face, and breech presentations are designated as occipito-iliac (O. I.), mento-iliac (M. I.), and sacro-iliac (S. I.). At the International Medical Congress which met in Washington in 1887 an attempt was made to secure greater uniformity in nomenclature, when it was suggested that the denomination "iliac" be omitted and the various presentations designated as occipital, mental, and sacral respectively. The suggestion was quite generally adopted in this country, and Bar in 1903 advocated its universal adoption.

As the presenting part in any presentation may be either in the left or



|                           | Position. | Presentation. | Variety.    | Abbreviation. |
|---------------------------|-----------|---------------|-------------|---------------|
| Vertex presentations..... | Left.     | Occipital.    | Anterior.   | (L.O.A.)      |
|                           | "         | "             | Transverse. | (L.O.T.)      |
|                           | "         | "             | Posterior.  | (L.O.P.)      |
|                           | Right.    | "             | Anterior.   | (R.O.A.)      |
|                           | "         | "             | Transverse. | (R.O.T.)      |
|                           | "         | "             | Posterior.  | (R.O.P.)      |



Fig. 201.



Fig. 202.

FIGS. 201, 202.—SHOWING VARIETIES OF VERTEX PRESENTATIONS.

|                         |        |         |             |          |
|-------------------------|--------|---------|-------------|----------|
| Face presentations..... | Left.  | Mental. | Anterior.   | (L.M.A.) |
|                         | "      | "       | Transverse. | (L.M.T.) |
|                         | "      | "       | Posterior.  | (L.M.P.) |
|                         | Right. | "       | Anterior.   | (R.M.A.) |
|                         | "      | "       | Transverse. | (R.M.T.) |
|                         | "      | "       | Posterior.  | (R.M.P.) |



Fig. 203.



Fig. 204.

FIGS. 203, 204.—SHOWING VARIETIES OF FACE PRESENTATIONS.

|                           |        |         |             |          |
|---------------------------|--------|---------|-------------|----------|
| Breech presentations..... | Left.  | Sacral. | Anterior.   | (L.S.A.) |
|                           | "      | "       | Transverse. | (L.S.T.) |
|                           | "      | "       | Posterior.  | (L.S.P.) |
|                           | Right. | "       | Anterior.   | (R.S.A.) |
|                           | "      | "       | Transverse. | (R.S.T.) |
|                           | "      | "       | Posterior.  | (R.S.P.) |



Fig. 205.



Fig. 206.

FIGS. 205, 206.—SHOWING VARIETIES OF BREECH PRESENTATIONS.

right position, we have left and right occipital, left and right mental, and left and right sacral presentations, which in an abbreviated form may be written L. O. and R. O., L. M. and R. M., L. S. and R. S. Again, as the presenting part in each of the two positions may be directed anteriorly, transversely, or posteriorly, we may have six varieties of each presentation, though the transverse modifications are frequently omitted. Thus, we have the classification given on the opposite page.

In Germany considerable confusion exists, as the various authorities still employ different classifications. Thus Schroeder, Olshausen and Veit do not distinguish variety at all, and designate the position according to the situation of the back of the child, speaking of first and second positions according as the back is directed to the left or right side of the mother respectively. Ahlfeld, Döderlein, and others employ a different nomenclature, and designate our L. O. A., R. O. A., R. O. P., and L. O. P. as first, second, third, and fourth positions respectively. The exhaustive articles of Müller and Schatz deal fully with this subject.

The nomenclature which we have adopted presents many advantages over the German, as it is based upon the relation of the presenting part to the maternal pelvis, and enables us to describe with accuracy the situation of the former at any period of labor.

**Frequency of the Various Presentations and Positions.**—According to the statistics collected by Schroeder, based upon several hundred thousand cases, the vertex presents in 95 per cent., the face in 0.6 per cent., and the breech in 3.11 per cent., transverse presentations occurring in only 0.56 per cent. of all cases. Markoe, in fifty-one thousand deliveries occurring in the New York Lying-in Hospital, noted 94.2, 0.48, 3.9, and 0.9 per cent., respectively. The former figures apply to all periods of pregnancy. But when full term alone is considered the predominance of vertex presentations becomes still more marked, constituting 96 to 97 per cent. of all cases; while breech presentations become less frequent, and occur only once in 62, as compared with once in 30 labors.

It is usually stated that about 70 per cent. of all vertex presentations occur in the left, and only 30 per cent. in the right position, and Schatz has shown that the former becomes more and the latter less frequent the nearer pregnancy approaches term. Naegle first pointed out that the vertex was usually directed anteriorly in left, and posteriorly in right positions; so that the presenting part is usually found at one or other extremity of the right oblique diameter of the pelvis, owing to the fact that the left oblique diameter is materially encroached upon at its posterior extremity by the rectum.

**Reasons for the Predominance of Head Presentations.**—Hippocrates recognized the overwhelming frequency of head presentations at the end of pregnancy, but believed that the child presented by the breech up to the seventh month, when it suddenly turned and presented by the head, the process being often expressed by the French term *culbute*.

As a result of the more frequent examination of pregnant women, the error of the Hippocratic teachings was gradually demonstrated, so that from the time of Smellie and Baudelocque it was generally believed that



head presentations predominated throughout all periods of pregnancy, but became more frequent in the later months. For many years it was taught that the presentation remained constant throughout pregnancy, and it was not until 1861 that Hecker and others demonstrated that it was not unusual for changes of position to occur even in the later months. Now it is universally admitted that the presentation does not become definitely established until the presenting part enters the pelvic canal, although it becomes more and more stable the nearer full term is approached.

The theories put forward to account for the prevalence of head presentations are divided into two groups, the one being based upon gravitation, the other supposing a process of accommodation between the fœtus and the uterine cavity.

The *gravitation theory* was especially advocated by Matthews Duncan and G. Veit, both of whom showed that a fœtus recently dead, when placed in a vessel containing a solution of salt having about the same specific gravity as itself (1.059-1.055), floated with its head and right side downward. This result they attributed to the greater specific gravity of the head, together with the presence of the liver on the right side. Veit also showed that head presentations increase in frequency with the advance of pregnancy, but that breech presentations were noted much more frequently when the child was dead. This he attributed to the fact that the specific gravity of the head became diminished after death.

Furthermore, it was pointed out that since the axis of the uterus, with the woman in the upright position, forms an angle of about 35 degrees with the horizon, provided the experiments of Duncan and Veit held good, the head would necessarily sink downward, and the convex back of the fœtus would adapt itself to the concave anterior wall of the uterus; then, since the left margin of the latter would usually be directed somewhat forward, the frequency of the left anterior presentations could be readily explained.

In 1900 doubt was cast upon the conclusions of Duncan and Veit by Schatz, who maintains that, although their results were perfectly correct when experimenting with a medium of the same specific gravity as the fœtus, it has yet to be demonstrated that they hold good for the amniotic fluid, which, it must be remembered, possesses a specific gravity of between 1.008 and 1.009, or considerably less than that of the fœtus. Schatz suspended a recently dead fœtus by the head and breech from the pans of a balance in a solution of salt of the same specific gravity as the amniotic fluid, and found that the breech had a greater tendency to sink down than the head; but, as the specific gravity of the fluid was gradually increased, the breech slowly rose until the long axis of the child became horizontal, and, as a density of 1.050 was approached, the head sank down as in Duncan's experiment. He therefore concluded that gravity alone does not account for the production of head presentations; for, if it were the most important factor concerned, breech presentations would predominate at the end of pregnancy. As this is not the case, some other influence must be invoked to explain the prevalence of the former. Seitz repeated this work, and upon determining the specific gravity of the

head and body of the fœtus, separately, found that the former was relatively lighter than the latter in the first eight months, but heavier in the last two months of pregnancy. Consequently, he concluded that gravity could only account for the predominance of head presentation in the latter period. Furthermore, as he found that the specific gravity was identical whether the fœtus were macerated or normal, and yet breech presentations were noted much more frequently in the former condition, he held that some other factor must be concerned.

This is supplied by the *theory of accommodation*, advanced by Dubois, Simpson, and Scanzoni, according to which cephalic presentations are brought about by a process of accommodation between the fœtal ovoid and the interior of the uterine cavity, the shape of the latter being such that the fœtus is most comfortable and fits it more accurately when presenting by the head. They held, therefore, that as soon as the fœtus came to occupy any other position its cutaneous surface became irritated, whence resulted reflex movements of the extremities, giving rise in turn to uterine contractions, which tended to restore the head presentation. Pinard is an enthusiastic advocate of this theory.

Schatz in 1904 clearly showed that there was a general tendency for the back of the child to lie anteriorly, which increased under the influence of gravity. This he demonstrated by finding that the anterior varieties of vertex presentations occurred more frequently in the evening than in the morning, in a series of women whom he examined in the morning before arising, and again in the evening after they had been about all day.

The frequency of abnormal presentations in the early months of pregnancy, and in all conditions in which the uterus is abnormally distended by an excess of amniotic fluid, tends to substantiate the accommodation theory; for in such cases the body of the child does not come in contact with the uterine walls, and accordingly the conditions necessary for the production of the reflex movements, which give rise to accommodation, are entirely lacking, and gravity alone comes into play.

An exhaustive consideration of the various older theories can be found in the excellent monograph of Cohnstein published in 1868.

## DIAGNOSIS OF PRESENTATION AND POSITION OF FŒTUS

The diagnostic methods at our disposal are fourfold: abdominal palpation, vaginal touch, combined examination, and auscultation.

**Obstetrical Palpation.**—Under ordinary circumstances external or abdominal palpation is the most reliable and valuable, and I should unhesitatingly choose it were I restricted to the employment of a single method of examination. In trained hands it enables one to make a satisfactory diagnosis without danger of infection and with the least possible discomfort to the patient, and it is not going too far to say that its popularization forms one of the greatest advances in modern obstetrics. Under these circumstances it behooves the student to become thoroughly familiar with



the proper technique, and to avail himself of every opportunity to become proficient in the various manipulations.

Although crude forms of abdominal palpation had no doubt been practiced from the earliest antiquity, just as they are still employed by many of the aboriginal peoples, its advantages were first pointed out by Roederer, Wigand, and Hohl, as late as the latter part of the seventeenth and the early part of the eighteenth century. Its practical importance, however, was not generally recognized until 1878, when Pinard published his work upon the subject, after which the method became popularized in France, but was not employed systematically in Germany and this country until Credé and Leopold had repeatedly urged its value.

In order to obtain satisfactory results, the examination should be made systematically by following the four manœuvres suggested by Leopold. The patient should be on a hard bed or sofa, with the abdomen bared, or at most covered with a thin chemise. During the first three manœuvres the examiner stands at the side of the bed which is most convenient to him, and faces the patient, but reverses his position and faces her feet for the last manœuvre. (See Plates X, XI, XII, and XIII.)

*First Manœuvre.*—After ascertaining the outlines of the uterus, the fundus is gently palpated with the tips of the fingers of the two hands, and the fœtal pole occupying it differentiated, the breech giving the sensation of a large, irregularly shaped, nodular body, and the head that of a hard, round object, which is freely movable and ballotable.

*Second Manœuvre.*—Having determined which pole of the fœtus lies at the fundus, the examiner places the palmar surface of his hands on either side of the abdomen and makes gentle but deep pressure. On one side he feels a hard resistant plane—the back—and on the other numerous nodulations—the small parts. In women with thin abdominal walls the legs and arms can readily be differentiated, but in fat persons only irregular nodulations can be felt. In the latter case, or when a considerable quantity of amniotic fluid is present, the appreciation of the back can be facilitated by making deep pressure with one hand while palpating with the other. After determining upon which side the back is situated, we next note whether it is directed anteriorly, transversely, or posteriorly, and thereby arrive at the position and variety of the presentation.

*Third Manœuvre.*—The examiner grasps the lower portion of the abdomen, just above the symphysis pubis, between the thumb and fingers of one hand, and tries to decide what is between them. If the presenting part be not engaged, a movable body will be felt, which is usually the head. The differentiation between it and the breech is made as at the fundus, the former being appreciated as a hard, round, ballotable body. If the presenting part be not engaged, this practically completes the examination, as we now know the situation of the head, breech, back, and extremities, and all that remains is to determine the attitude of the head. If careful palpation shows that the greatest cephalic prominence is on the same side as the small parts, we know that the head is flexed and that the vertex is the presenting part; but when the reverse is the case we know that the head is extended and that we have a face presentation. On the other hand,

if the presenting part be engaged, this manœuvre simply shows that the lower pole of the fœtus is fixed in the pelvis, and the details concerning it are ascertained as follows:

*Fourth Manœuvre.*—The examiner faces the patient's feet, and with the tips of the first three fingers of each hand makes deep pressure in the direction of the axis of the superior strait. If the head presents, he finds that one hand is arrested sooner than the other by a round body—the cephalic prominence; while the other hand descends deeper into the pelvis. In vertex presentations the prominence is on the same side as the small parts, and in face presentations on the same side as the back. Again, the degree of ease with which the prominence is felt indicates the extent to which descent has occurred. In many instances, when the head has descended into the pelvis, the anterior shoulder of the child can be readily differentiated by the third manœuvre. In breech presentations the information obtained from this manœuvre is not so definite as in head presentations.

This method of examination is available throughout the later months of pregnancy, and in the intervals between the pains at the time of labor. By its use we can not only determine the presentation and position of the child, but also obtain important information as to the extent to which the presenting part has descended into the pelvis. At the same time the size of the child can be roughly estimated, and the second fœtus mapped out in twin pregnancy.

During uterine contractions, on carefully palpating in the region of the internal abdominal ring, one can often distinguish a rounded cord on either side—the *round ligaments*—from which important information may be obtained. In the first place, the intensity of their contraction gives some idea of the manner in which the uterus is acting; and secondly, by noting their course, as pointed out by Palm and Leopold, we are enabled to diagnose the situation of the placenta in about 88 per cent. of all cases. When the round ligaments are found converging toward the fundus of the uterus, the placenta is usually situated upon the posterior wall, whereas it is upon the anterior wall when they are parallel or diverging.

During labor, palpation also gives us valuable information concerning the *lower uterine segment*; when there exists some obstruction to the passage of the child, the *contraction ring* may be felt as a transverse or oblique ridge extending across the lower portion of the uterus. Moreover, in normal cases, we can differentiate by palpation between the contracting body of the uterus and the passive lower uterine segment; for during a pain the former presents a firm, hard sensation, while the latter appears elastic and almost fluctuant.

**Vaginal Examination.**—During pregnancy the results arrived at by vaginal examination, concerning the presentation and position of the child, are necessarily somewhat inconclusive, as one is obliged to palpate the presenting part through the lower uterine segment. During labor, on the other hand, after more or less complete dilatation of the cervix, important information may be obtained. In vertex presentations the position and variety are determined by the differentiation of the various sutures and



fontanelles; in face presentations, by the differentiation of the various portions of the face; and in breech presentations, by the palpation of the sacrum and ischial tuberosities.

Under the most favorable circumstances the information to be derived from vaginal touch alone is not more accurate than that obtained by abdominal palpation, and in vertex presentations the fontanelles are not infrequently mistaken for one another; and occasionally face and breech presentations escape differentiation. Moreover, in the latter part of labor, after the formation of a fluid tumor beneath the skin covering the presenting part—the *caput succedaneum*—detection of the various diagnostic points often becomes impossible.

A much more serious objection, however, is the danger of puerperal infection, no matter how carefully the obstetrician may have attempted to

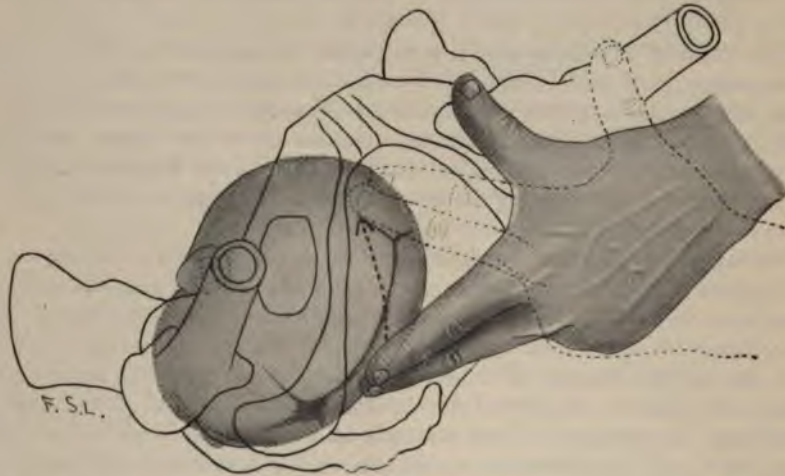


FIG. 207.—DIAGRAM SHOWING METHOD OF LOCATING SAGITTAL SUTURE ON VAGINAL EXAMINATION.

disinfect his hands; for it is now generally admitted that absolute hand disinfection cannot be effected, and, even granting that the use of rubber gloves overcomes this difficulty, the gloved fingers may still carry up into the vagina pathogenic microorganisms from the margins of the vulva, and thus give rise to infection. Moreover, vaginal examination necessitates exposure of the patient, and subjects her to more or less serious inconvenience.

Accordingly, it is advisable to limit its employment as much as possible, and in normal cases to do away with it altogether. For if the patient has a normal pelvis, and we find by the fourth manœuvre that the head is deeply engaged, all that we gain by vaginal examination is information as to the degree of dilatation of the cervix, and this can usually be ascertained by rectal examination. Accordingly, vaginal examination becomes absolutely necessary only in the few cases in which palpation and rectal exam-

ination do not give satisfactory results, or in those presenting some abnormality, or in which the course of labor is unduly delayed. Personally, I conduct more than three-quarters of my private cases in this manner, and do not make a vaginal examination until about to discharge the patient.

In attempting to diagnose the presentation and position by vaginal examination, it is advisable to pursue a definite routine, which is readily accomplished by three manœuvres.

*First Manœuvre.*—After most careful hand disinfection and appropriate preparation of the patient, two fingers of either the right or left hand, as best suits the examiner, are introduced into the vagina and carried up to the presenting part. A few moments suffice to determine whether it is a vertex, face, or breech.

*Second Manœuvre.*—If the vertex be presenting, the fingers are carried up behind the symphysis pubis, and are then swept backward over the

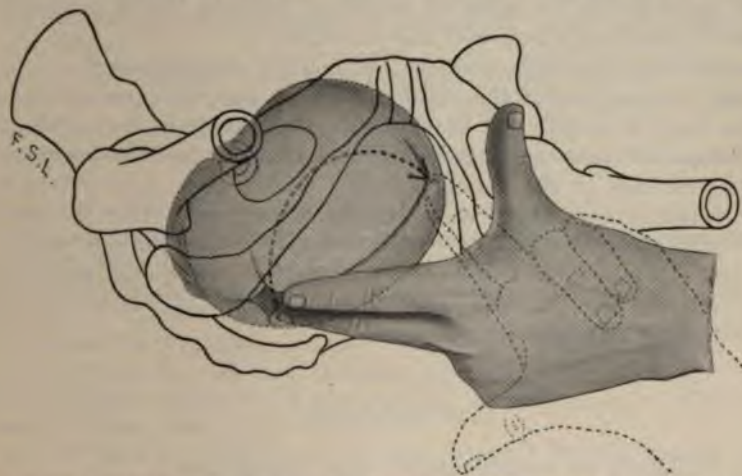


FIG. 208.—DIAGRAM SHOWING METHOD OF DIFFERENTIATION BETWEEN THE FONTANELLES.

head toward the sacrum. During this movement they necessarily cross the sagittal suture. When it is felt, its course is outlined, and we know that the small fontanelle lies at one and the large fontanelle at the other end of it.

*Third Manœuvre.*—We then attempt to determine the position of the two fontanelles. For this purpose the fingers are passed to the anterior extremity of the sagittal suture, and the fontanelle there encountered is carefully examined and identified; then, by a circular motion, the fingers are passed around the side of the head until the other fontanelle is felt and differentiated. By this means the various sutures and fontanelles are readily located, and the possibility of error is considerably lessened. In face and breech presentations it is still further minimized, as the various parts are more readily distinguished.

*Combined Examination.*—By combined examination we understand the introduction of two fingers of one hand into the vagina, and the appli-



cation of the other hand over the lower portion of the abdomen. This method is rarely employed except when the presenting part is not engaged, and the external hand is used to fix it so as to permit the internal fingers to explore it satisfactorily.

**Auscultation.**—By itself, auscultation does not give very important information as to the presentation and position of the child, but it not infrequently reinforces the results obtained by palpation. Ordinarily, the heart sounds are transmitted through the convex portion of the fœtus, which lies in intimate contact with the uterine wall. Accordingly they are heard loudest through the back in vertex and breech, and through the thorax in face presentations. The region of the abdomen in which the fœtal heart is heard most plainly varies according to the presentation and the extent to which the presenting part has descended. In head presentations the point of maximum intensity is usually midway between the umbilicus and the anterior superior spine of the ilium, while in breech presentations it is usually about on a level with the umbilicus.

Auscultation frequently gives us not a little supplementary aid in determining the position of the child. Thus, in occipito-anterior presentations the heart is usually best heard a short distance from the middle line; in the transverse varieties it is heard more laterally, and in the posterior varieties well back in the patient's flank. Occasionally, however, in right occipito-posterior presentations, the information gained from the position of the fœtal heart is misleading, and may give rise to serious diagnostic errors; for if the flexion of the head be imperfect, the thorax may become convex, and the heart sounds being transmitted through it would apparently indicate a left anterior position.

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## SECTION IV

### *PHYSIOLOGY OF LABOR*

#### CHAPTER X

##### THE PHYSIOLOGY AND CLINICAL COURSE OF LABOR

By labor we understand the process which brings about the separation of the mature or nearly mature product of conception from the interior of the uterus, and its extrusion from the maternal organism, whether the birth occurs spontaneously or requires external aid.

**Cause of the Onset of Labor.**—From time immemorial inquiring minds have sought an explanation for the fact that labor usually ensues about two hundred and eighty days after the appearance of the last menstrual period, but thus far no satisfactory universal cause has been discovered. The following are among the most important theories which have been advanced as to its causation:

1. The growing irritability of the uterus, associated with an increase in the frequency and strength of the intermittent contractions.
2. Increasing distention of the uterus.
3. Dilatation of the cervix by the presenting part.
4. Increasing distention of the lower uterine segment, with pressure upon the neighboring nervous structures.
5. Changes in the decidua—loosening, thinning, and thrombosis.
6. Excess of carbon dioxide or lack of oxygen in the placental blood, acting on nervous centers.
7. The circulation of foetal metabolic products acting upon similar centers.
8. Menstrual periodicity.
9. Anaphylactic action of foetal blood.
10. Heredity and habit.
11. Senility of the placenta.
12. Physical and emotional causes.

1. The increasing readiness with which the uterus reacts to stimulation during the later months of pregnancy affords abundant evidence of its growing irritability. The intermittent contractions, which occur at intervals throughout pregnancy, come on more frequently at this time, and with so much greater intensity that it is oftentimes difficult, in the last few weeks before delivery, to distinguish between them and actual labor pains.

2. Since the time of Mauriceau it has been believed that the uterus, when distended up to a certain point, must begin to contract and attempt to empty itself, just as happens in the case of any other hollow viscus. This presumption is supported by the frequency with which premature labor occurs in hydramnios or twin pregnancies. On the other hand, extreme distention does not necessarily give rise to labor, as is shown by the cases of prolonged pregnancy which are associated with large children.

3. Galen supposed that labor resulted from gradual dilatation of the cervix, which was brought about by the pressure of the presenting part, and the view still has numerous adherents. That the condition of the cervix is not the sole factor is shown by the fact that in a certain number of instances, especially in twin pregnancies, considerable dilatation may exist for days or even weeks before the onset of labor.

4. Keilmann and Knüpfner advanced the theory that the onset of labor was the result of the gradual formation of the lower uterine segment, with consequent pressure upon the surrounding nervous ganglia. Their work was done upon the bat, and was quite convincing so far as that animal is concerned, but it is questionable whether identical factors are concerned in human beings.

5. Naegele, Simpson, Scanzoni, and others believed that the decidua in the latter weeks of pregnancy underwent fatty degeneration, which resulted in the partial separation of the ovum and its practical conversion into a foreign body, which then gave rise to uterine contractions. More recent investigations, however, have shown that such changes do not occur normally.

It has also been stated that the septa, by which the glandular spaces of the spongy layer of the decidua are bounded, become progressively thinner in the later months of pregnancy, so that in the last few weeks they tend to rupture and thereby bring about more or less extensive separation of the ovum from the uterine wall. No doubt the septa are considerably thinner in the later than in the earlier months of pregnancy, but they are not torn through until after the expulsion of the foetus.

6. Brown-Séquard in 1853 demonstrated that an excess of carbon dioxide in the blood led to energetic uterine contractions, and his statements have been confirmed by most subsequent investigators (Keiffer). Even if this be true, no one has as yet adduced evidence of a sudden increase in the amount of carbon dioxide in the blood sufficient to give rise to labor at the appointed time; although Leopold and others contended that the carbon dioxide content of the placental blood is markedly increased as a result of progressive thrombosis of the decidual vessels.

On the other hand, recent work tends to invalidate Brown-Séquard's conclusions. Blumreich holds that carbon dioxide has less effect upon the pregnant than upon the non-pregnant uterus, while Kurdinowsky and Kehrler contend that it does not give rise to contractions at all.

7. Spiegelberg advanced the view that the onset of labor was due to foetal rather than maternal changes. He considered that the mature foetus needed materials for its sustenance other than those furnished by the placenta, and that as a result of insufficient nutrition certain excrementitious



substances gained access to the maternal circulation, and in some way stimulated the uterus.

The observations of Kurdinowsky upon the isolated uterus, of Kehrer upon the extirpated living uterus, of Kruieger and Offergeld upon the uterus separated from all connection with the central nervous system, of Sauerbruck and Heyde in symbiotic experiments, as well as various metabolic studies, tend to indicate that the ultimate cause of labor must be sought in some substance or substances circulating in the maternal blood. We are profoundly ignorant of the nature of this hypothetical substance, and do not know whether it is derived from the foetus, the ovaries, or the general organism of the mother, although certain evidence points toward the former.

In the experimental and clinical observations of Kruieger and Offergeld, in which the uterus was cut off from all connection with the central nervous system, labor set in at the usual time and progressed normally. Accordingly, it must be admitted that the process is not dependent upon the stimulation of centers situated in the central nervous system, but is attributable to the stimulation of the intra-uterine ganglia by substances brought to the uterus either by the circulating blood, or originating in the foetus itself. Furthermore, the experiments of Sauerbruck and Heyde, which I have been able to confirm to some extent, point to a similar conclusion. These investigators united rats to one another in such a manner that they continued to live in symbiosis, and, if both animals were pregnant, they found that the occurrence of labor in one set up a similar process in the other; while, if only one were pregnant, the onset of labor was associated with serious illness on the part of the non-pregnant animal. Such observations indicate that the cause of labor must be sought in the circulation of some substance in the blood, which is comparatively innocuous to pregnant but poisonous to non-pregnant animals; but at the same time they give no information concerning its nature or origin.

8. Mende, Tyler-Smith, Löwenhardt, Beard, and others believe that there is an increased tendency toward uterine contractions at the periods at which the menstrual flow should appear if the patient were not pregnant, and that these reach their acme at about the date of the tenth menstrual period and give rise to labor. Observations of this character point toward the possibility of an ovarian hormone being the efficient cause.

9. Von der Heide considers that the cause of labor should be sought in an anaphylactic reaction. He claims that in a certain proportion of cases labor will follow the intravenous injection of a few cubic centimeters of foetal serum. In normal pregnancy he holds that foetal substances are constantly gaining access to the maternal circulation, and give rise to the formation of definite antibodies. As term approaches, he believes that excessive quantities of the foetal antigen enter the mother's blood, and that in the reaction which ensues between it and the existing antibodies, substances are set free which give rise to labor.

It is as yet too early to express an opinion concerning the correctness of this hypothesis, but, in view of the collapse of the anaphylactic theory

in connection with the production of eclampsia, it should be held *sub judice* until further confirmatory evidence becomes available.

10. Geyl and others are inclined to attribute the onset of labor at the usual time to the fact that Nature, after ages of experiment, has found the end of the tenth month to be the most suitable time. For when labor occurs at a later period it is usually very difficult and results in dead children, while at an earlier period puny children are born which usually perish soon after birth.

11. Eden and the writer have pointed out that the frequent occurrence of infarct formation in the placenta at term must be regarded as evidence of its senility, and as analogous to the atrophy of the chorion laeve at an earlier period. Where these changes are marked the nutrition of the foetus must be interfered with, and it is possible that certain of its metabolic products may result in stimulation of the uterine centers.

12. It is also a well-known fact that excessive physical exercise, sudden jars or violence, as well as extreme mental emotion, such as grief and anger, may lead to the termination of pregnancy.

While, then, there is no lack of theories upon the subject, at the same time it is manifest that most of them are extremely unsatisfactory, and, with the exception of the recent "biological" ones, that none are of universal application. It is probable, therefore, that in the majority of cases the onset of labor is due to the combination of a number of the above-mentioned causes, and that only some slight stimulus or irritant is needed to set it in progress. On the other hand, it is possible that some law may be discovered in the future which will explain the rhythm of the various sexual functions in women—menstruation, as well as the onset of labor.

Observations made in my clinic show that marked changes in metabolism occur immediately before and at the time of labor, which in all probability stand in some causal relation to it. Thus, Slemmons has shown that twenty-four hours or less before the onset of labor the output of nitrogen through the urine is considerably diminished, while at the same time a marked diuresis occurs, thus completely reversing the conditions which existed throughout the last months of pregnancy. Accordingly, if the urinary analysis could be made promptly enough it might afford a means of predicting the approaching onset of labor.

In order to determine the relation which these changes bear to the causation of labor, Slemmons, at my suggestion, studied the metabolism of two pregnant women in whom pregnancy was interrupted by the introduction of a bougie, and found that the changes were absent, or at least much less marked than when labor occurred spontaneously.

We are not yet prepared to draw positive conclusions from these observations, but, nevertheless, they seem to indicate that at least two factors may be concerned in the production of labor. One is connected with some process which gives rise to a pronounced alteration in metabolism, and occurs in spontaneous labor; while the second, which is a purely mechanical irritation, is not accompanied by such changes. What the first factor is cannot be determined as yet, but it seems difficult to escape the inference that it is some substance which gains access to the circulation and pro-



foundly alters the entire metabolism, and at the same time directly or indirectly stimulates the uterus to contraction.

Moreover, observations which I have made upon the respiratory exchange show that at the time of labor the output of carbon dioxide is less than one would expect in view of the increased muscular exertion incident to labor. Accordingly, as the latter must necessarily be accompanied by an increased production of carbon dioxide, it must follow that that resulting from the general bodily activity is diminished, so that it may be assumed that labor is accompanied by profound changes which depress the general oxidative processes far below the usual limit.

Nearly all of the theories to which reference has been made require the intervention of the central nervous system for the ultimate production of labor, and it is generally stated that there exists in the medulla a center for uterine contractions, which can be stimulated by anæmia and the presence of various toxic substances.

Recent investigations, however, have thrown considerable doubt upon its existence, and render it probable that the only uterine center is situated in the lumbar column, and that even it is not absolutely essential to the onset and completion of normal labor. The work of Franz, Kurdinowsky, and Kehrer clearly shows that the intrinsic nerve supply of the uterus may suffice for its usual activities. Kurdinowsky has observed the completion of labor in isolated uteri, which were kept alive by the circulation of Locke's fluid through their vessels; while Kehrer has shown that excised portions of the uterus of animals and women may live for hours in oxygenated Ringer's fluid, and that their contractions may be graphically recorded by suitable appliances.

As early as 1880, Rein showed that the transmission of impulses through the cord is not essential to the act of labor, while the more extensive experiments of Krueger and Offergeld prove that in animals section of the cord, and the separation of the uterus from all extrinsic nerve connections, has no further effect upon labor than to render it painless. Moreover, their observations, as well as those of Routh and others, upon the course of labor in women who have sustained destructive injuries of the lower part of the spinal cord show that labor may progress painlessly and normally, except by the absence of expulsive efforts on the part of the abdominal wall.

Although Keiffer and others have shown that the uterus has a three-fold nervous supply, which is derived principally from the sympathetic system, partly from branches of the lumbar cord, and partly from its intrinsic nerves, and that contractions may follow the stimulation of any of them, the evidence at our disposal indicates the following conclusions: That the intrinsic nerves are the main factor concerned in the production of uterine contractions; that the central nervous system has principally a regulative function, makes possible the perception of pain, and controls the voluntary abdominal contractions; and that the sympathetic system regulates the vascular conditions.

**Labor Pains.**—With the onset of labor, the painless intermittent contractions which have persisted throughout pregnancy are replaced by others

of increasing intensity, giving rise to severe pain, and bringing about the dilatation of the cervix and the expulsion of the child and placenta.

The uterine contractions, just as those of all other non-striated muscles, are independent of the will of the patient, and can neither be increased nor diminished in frequency by her volition. But at the same time they may be affected by the emotions, and any sudden excitement may either check them or cause them to become more violent. Thus, it is a matter of common observation that the entrance of the obstetrician may be followed by a marked lull in the intensity and frequency of the pains.

The contractions begin slowly, gradually reach an acme, and then gradually diminish in intensity, the active process being followed by a pause of some length. The tracings of Schatz and Polaillon show that the period of increase occupies the greater portion of the pain, and that its acme is of very short duration. In the lower animals which possess bicornuate uteri the contractions are distinctly peristaltic in character; and Schatz believes that such is also the case in human beings. It is important to bear in mind that labor pains are effective only during the period of increase, and that the tightly contracted organ is worthless from a mechanical standpoint.

These uterine contractions are nearly always accompanied by painful sensations, whence the term "labor pains," although the amount of suffering varies markedly in different individuals. The pain usually begins in the sacral region and then slowly passes to the abdomen and down the thighs. In the early stages of labor it is due almost exclusively to pressure upon the nerve endings between the muscle fibers; but in the later stages it is augmented by the overstretching and dilatation of the soft parts, and becomes most marked when the head distends the vulva just before its birth. Usually the final pains are very severe, and may be almost insupportable, but occasionally the suffering is very slight, and, in rare instances, labor may be almost entirely painless, even though the patient be perfectly conscious. A considerable number of such cases have been collected by Coliez and Wolff.

At the onset of labor the pains come on at intervals of from fifteen to thirty minutes; as it advances they gradually become more frequent, and eventually occur every two or three minutes. Their average duration is about one minute—thirty to ninety seconds—though suffering is not experienced during the entire contraction, as the hand placed over the abdomen may feel the uterus becoming hard for several seconds before the patient perceives the slightest pain.

**Force Exerted by Labor Pains.**—On this point there has been a good deal of misconception, and a marked tendency toward exaggeration appears in the writings of not a few authors. Thus Sterne, in Tristram Shandy, estimated that the force exerted at each pain during labor amounted to 470 pounds, while Professor Haughton put it at 577 pounds. Poppel, Duncan, Ribemont, and others have attempted to approximate it by trying to determine the force necessary to cause the rupture of the membranes outside of the body. This, they found, varied markedly, and in 100 ex-



periments Duncan placed the extremes at 4 and 37.58 pounds respectively, with an average of 16.73 pounds.

Joulin and other observers have attempted to solve the problem by calculating the force exerted in forceps deliveries. Thus, on interpolating a dynamometer between the operator and the ends of the instrument, it was found that the tractile force rarely exceeded 80, though in some cases it reached 100 pounds. A greater force than this cannot come into play, as it has been shown that one of 120 pounds is sufficient to tear the child's head from its body.

Schatz studied the subject by inserting into the uterus a rubber bag which was connected with a manometer. In this way he found that the intrauterine pressure, in the intervals between the contractions, was represented by a column of mercury 20 millimeters high, 5 of which were due to the tonicity of the uterine walls and 15 to its contents. During the pains, however, the mercury rose to a height of from 80 to 250 millimeters, which corresponds to a force of  $8\frac{1}{2}$  to  $27\frac{1}{2}$  pounds. He also showed that the force exerted by the uterus increases markedly when the fœtus is partially expelled from it.

A rough idea may also be gained by estimating the expenditure of energy necessary to restrain the head as it emerges from the vulva. This rarely exceeds 50 pounds, although the obstetrician not infrequently finds it impossible to hold it back at the acme of a pain. This inability is in great part due to the disadvantageous manner in which one is obliged to exert one's energy, rather than to the actual force exerted by the uterine and abdominal contractions.

**Physical Changes during Uterine Contractions.**—During contraction the uterus undergoes marked changes in shape. With the patient on her back, the organ in the flaccid state rests upon the vertebral column, and its transverse equals or exceeds its vertical diameter. But when it contracts the uterus leaves the vertebral column, becomes more erect, and pushes the anterior abdominal wall forward. At the same time the vertical increases at the expense of the transverse diameter (Fig. 209).

The dilatation of the cervix is usually brought about solely by the action of the uterine muscles, whereas during the expulsion of the child those of the abdominal wall also come into play. During the second stage the patient braces her body against some fixed object, takes a deep inspiration, closes the glottis, and makes forcible straining movements with the abdominal and respiratory muscles. By these means the intraabdominal pressure is markedly increased, and is transmitted directly to the uterus. At first these movements are voluntary, but as labor advances they pass beyond the control of the will, and may occur even with the patient under profound anæsthesia.

The abdominal muscles, therefore, play an important part in the expulsion of the child, which in many instances makes no progress without their aid. The fact that spontaneous labors occasionally occur in women who are paralyzed from the waist down shows that their action is not indispensable in every case; but, on the other hand, the application of low forceps is frequently rendered necessary by the inability of the abdominal

muscles to do their work, or to the unwillingness of the patient to bear the pain associated with their employment.

The various ligamentary structures connected with the uterus also take part in the contractions. Of these the most important are the round ligaments, which in contracting tend to draw the fundus of the uterus forward and to fix it in position. They can be readily palpated through the abdominal wall, and some idea of the intensity of the uterine contractions may be gained from their consistency.

The part played by the vagina during labor is almost entirely passive, and it is only after the expulsion of the child that the contraction of the muscular elements in its walls comes into play.

The general arterial tension is raised during the labor pains, as is in-



FIG. 209.—COMPOSITE PICTURE, SHOWING SHAPE OF ABDOMEN BEFORE AND DURING A UTERINE CONTRACTION, THE DARKER OUTLINES INDICATING CONTRACTION.

indicated by the flushed look of the patient, as well as by the more accurate observations of Vaquez, and of Slemons and Goldsborough in my clinic. The pulse becomes accelerated during, and slower in the intervals between, the pains. It is also stated that the temperature rises a fraction of a degree during each pain, though its detection requires the employment of very accurate thermometers. Respiration becomes slower during the contractions, more rapid in the interval between them, and is totally abolished during the expulsive pains of the second stage of labor. My observations upon the respiratory exchange show that the consumption of oxygen and the output of carbon dioxide are increased during labor, but not to the extent one would suppose. I have already stated that this probably indicates that the general oxidative processes of the body are reduced to a minimum at this time, and consequently that the actual work of labor is accomplished with comparatively less expenditure of energy than in the case of an equal amount of muscular exertion at other times.

**Clinical Course of Labor.**—Before taking up the consideration of the forces concerned in the expulsion of the fœtus and the mechanism by which



it is accomplished, it is advisable for the student to follow as a spectator the course of parturition in a primiparous woman.

Several weeks before the onset of labor the abdomen undergoes a marked change in shape, its lower portion becoming more pendulous, whereas in the neighborhood of the costal margin it looks decidedly flatter. This change is perceived by the woman herself, who feels that her waist has become lower; and occasionally it occurs so suddenly as to cause her to fear that something has given way inside her abdomen.

Abdominal palpation at this period shows that the fundus of the uterus has descended from the position which it occupied at the ninth month, and resumed that of the eighth; while the third manœuvre shows that the head, which was previously freely movable, has become fixed in the superior strait. These changes are most marked in primiparæ, and frequently do not occur in multiparæ until the onset of labor.

After this the patient experiences considerable relief from the respiratory disturbances from which she may have suffered; but at the same time locomotion may become more difficult, and she may suffer from severe cramp-like pains in the lower extremities and a more frequent desire to urinate.

During the last few weeks of pregnancy the vaginal secretion is increased in amount, the labia become more swollen and succulent, and in multiparæ gape more or less widely, while the patient may frequently experience a few transient pains for a number of days before confinement.

For purposes of description, labor is divided into three stages: The first, or period of dilatation, extends from the commencement of labor until the cervix is completely dilated. The second, or period of expulsion, extends from the complete dilatation of the cervix to the birth of the child; while the third stage, or placental period, lasts from the birth of the child to the extrusion of the placenta.

*First Stage.*—About the end of the tenth lunar month the patient begins to experience cramp-like pains in the lower portion of her abdomen, which she frequently mistakes for intestinal colic. At first these sensations recur only at long intervals, but soon are felt more frequently. They are most marked in the lumbar region and gradually extend toward the abdomen and down the thighs. As the pains become more frequent they likewise increase in severity, and in the latter part of the first stage the patient may complain bitterly, and often seeks to ease herself by making pressure over the sacral region.

The result of the pains in this stage of labor is to bring about the dilatation of the cervix, and, as it slowly yields to the pressure of the amniotic fluid contained in the membranes, slight lesions occur about its margins, which are manifested by a small admixture of blood with the vaginal discharge—the “show.” During this period the patient is perfectly comfortable between the pains, and for a time can attend to her ordinary avocations; but, as they become more severe, she assumes a sitting or leaning posture, and frequently gives utterance to short, sharp, querulous cries.

After the pains have continued for from twelve to fifteen hours, more or less, there is a sudden gush of clear fluid from the vagina, which in the

majority of cases indicates that the cervix has become completely dilated, and that the membranes, having fulfilled their function as a hydrostatic wedge, have ruptured. The amount of fluid which escapes varies according to the situation of the point of rupture and the position of the presenting part. In vertex presentations, where the pelvis is normal, the cervix is tamponed, so to speak, by the rounded head, and only a small portion of liquor amnii escapes. On the other hand, if the head be not engaged, or there be some disproportion between it and the presenting part, the entire amount of amniotic fluid may escape. But even in perfectly normal cases a small quantity gushes out with each pain.

Not infrequently the membranes may rupture before complete dilata-



FIG. 210.—BIRTH OF HEAD, SCALP APPEARING AT VULVA.

tion of the cervix, and occasionally even before the onset of labor. Under such circumstances the presenting part has to act as a dilating wedge, and, as it fills out the cervix less completely and accurately than the unruptured membranes, dilatation proceeds more slowly. These are instances of what are commonly known as *dry labors*. Exceptionally, several days or even a week or longer may elapse between the rupture of the membranes and the onset of labor, so that in such cases one should be cautious in expressing an opinion as to when labor will begin. Meyer-Ruegg in 1904 collected from the literature 15 cases in which several months elapsed between this occurrence and the completion of labor, though so long an interval is very unusual.



*Second Stage.*—For a short time after rupture of the membranes there is a lull in the labor pains, after which they recur with increasing frequency and vigor, and compel the patient to take to her bed, where if left to herself she assumes a crouching or squatting posture. During this period the abdominal muscles are brought into play. At first the patient, with each uterine pain, may cause them to contract by an effort of her will. Later, however, this act becomes involuntary, and she is usually unable to resist bearing down. At the onset of the pain she braces her feet against some solid object, takes a deep inspiration, and brings her abdominal and respiratory muscles into active play, her efforts being accompanied by a characteristic grunting sound. At the same time her face becomes marked-



FIG. 211.—BIRTH OF HEAD, VULVA PARTIALLY DISTENDED.

ly congested, and in the later stages of labor covered with sweat. As the pain passes off, the glottis is opened and respiration reëstablished, the same phenomena being repeated as soon as another contraction comes on.

It is during this period that the child descends through the pelvis. After expulsive pains have continued for about an hour the patient experiences a marked desire to go to stool, which indicates that the head has passed into the pelvic cavity and is pressing upon the rectum. In a short time the pelvic floor may be seen to bulge with each pain, and a little later the scalp of the foetus may be detected through the slit-like vulval opening. With each subsequent pain the perineum bulges more and more, and the vulva becomes more and more dilated and distended by the

head, being gradually converted into an ovoid, and at last into an almost circular opening. With the subsidence of each contraction, it becomes smaller and the head recedes from it, to advance again with the next pain.

As labor progresses the perineum becomes still more distended and thinner, especially in its anterior portion; so that eventually its frenulum does not exceed a piece of paper in thickness, and looks as if it would rupture with each pain. At the same time the anus becomes markedly stretched and protuberant, and the anterior wall of the rectum protrudes through it. By this time the perineum has become converted into a deep gutter, 5 to 6 centimeters long, at the end of which is the vulval opening,



FIG. 212.—BIRTH OF HEAD, VULVA COMPLETELY DISTENDED.

which looks almost directly upward and is distended by the head of the child, the occiput being pressed firmly against the symphysis pubis. The distention of the vulva is most marked at its perineal margin, and only slight at its lateral portions.

The head advances a little with each pain and recedes in the intervals between them. This continues until the parietal bosses become engaged in the vulva, when further recession becomes impossible, and with the next two or three pains the head is rapidly expelled by a movement of extension, the base of the occiput rotating around the lower margin of the symphysis pubis as a fulcrum, while the bregma, brow, and face successively pass over the fourchette. In the majority of cases the perineum is unable to



withstand the strain to which it is subjected, and tears in its anterior portion, though usually only to a slight extent.

Immediately after its birth the head falls backward, so that the face comes almost in contact with the anus. In a few moments the occiput turns toward the one or other thigh, and eventually the entire head assumes a transverse position. This is known as external rotation or restitution, and serves to bring the bisacromial diameter of the child into relation with the antero-posterior diameter of the pelvic outlet.

At this time the perineum is quite tightly retracted around the neck of the infant, whose face in consequence may become markedly congested, so that the inexperienced obstetrician is often seized by an almost uncontrol-



FIG. 213.—BIRTH OF HEAD, SHOWING DELIVERY BY EXTENSION.

lable desire to extract the child by traction upon the head. This, however, is usually unnecessary, for the next pain forces the anterior shoulder down under the symphysis pubis, where it becomes fixed; while the posterior shoulder emerges over the anterior margin of the perineum, after which the body of the child is rapidly expelled by a movement of lateral curvature, corresponding to the axis of the birth canal.

Immediately following the child comes a gush of amniotic fluid, which represents the portion which did not escape at the time of rupture of the membranes, and is more or less tinged with blood.

In primiparous women the second stage of labor usually lasts about two hours, and a much shorter period in multiparous women, in whom two

or three pains sometimes suffice for the completion of the period of expulsion.

*Third Stage.*—For a few minutes after the birth of the child there is a cessation of the uterine contractions, and the patient experiences a marked sense of relief. On glancing at the abdomen it is seen that the uterus has become much smaller and forms a solid tumor whose upper margin lies well below the umbilicus. After a longer or shorter period the uterine contractions commence once more, and a few moments later the fundus of the uterus may be seen to rise up for several centimeters, while a slight tumefaction appears immediately above the symphysis pubis. (See Figs. 303 and 304.) This indicates that the placenta has become



FIG 214.—BIRTH OF HEAD, FACE FALLING BACKWARD TOWARD ANUS.

separated from the interior of the uterus and is now in the lower uterine segment or the upper portion of the vagina. From this position it is expelled by the action of the abdominal muscles, the time varying according to the efficiency of their contraction. In some women the entire placental period may be terminated spontaneously within a few minutes after the birth of the child, while in others the placenta may remain in the lower uterine segment for hours unless forced from it by proper manipulation on the part of the obstetrician.

During the third stage there is nearly always a slight amount of hæmorrhage, which in normal cases amounts to 300 or 400 cubic centimeters. Not infrequently the patient may have a chill during this period, or im-



mediately after its completion. This, although it may appear somewhat alarming, in itself has no significance, as it is merely a vasomotor phenomenon.

**Duration of Labor.**—The duration of labor presents considerable individual variations, and is usually about six hours longer in primiparæ than in multiparæ. Generally speaking, the average for the former is about eighteen hours, of which sixteen are occupied by the first, one and three-quarters to two by the second, and a quarter to a half hour by the third stage of labor; for the latter it is about twelve hours, eleven of which are occupied by the first, and one by the second stage.

According to G. Veit, the average duration of labor is twenty hours



FIG. 215.—BIRTH OF HEAD, EXTERNAL ROTATION.

for primiparæ and twelve for multiparæ; according to Spiegelberg, seventeen and twelve hours respectively. The slower course of labor in the former is due to the greater resistance offered by the soft parts. Occasionally labor may be extremely rapid, and even in primiparæ the entire process is sometimes completed within a few hours; while, on the other hand, a duration of twenty-four to thirty-six hours or even longer is not unusual.

Labor is usually more prolonged in elderly than in young primiparæ—that is, after the thirtieth year. According to Ahlfeld, it averages seven hours longer in the former, though Varnier states that the difference is very much less. At the same time the latter author points out that forceps

are much more frequently required in old primiparæ, being applied in 25 per cent. and 1.6 per cent. of the cases respectively, thus indicating that labor would have lasted much longer had it not been terminated by operative means. It is usually considered that labor is likewise prolonged in extreme youth, but the observations of Gache and Bondy prove that such a belief is erroneous.

It is generally stated that delivery occurs most frequently between the hours of 2 and 4 a. m. The statistics of Knapp, which are based upon 39,000 cases, show that this is not correct, and that more children are born between 9 and 12 p. m. than in any other three hours of the day. Furthermore, if the cases be divided into two groups, according as delivery occurs between 6 a. m. and 6 p. m., and 6 p. m. and 6 a. m. respectively, it will be found that only 4 or 5 per cent. more children are born in the latter than in the former period. The general belief that most labors occur at night is due to the fact that the process usually lasts more than twelve hours, and accordingly either its beginning or end must necessarily fall between 6 p. m. and 6 a. m.

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## CHAPTER XI

### THE FORCES CONCERNED IN LABOR

**The Cervix in the Later Part of Pregnancy.**—On vaginal examination in the later months of pregnancy, the cervix is found to be much softer and somewhat broader than in the non-pregnant condition. At the same time it usually gives the impression of being considerably shortened, especially in its anterior portion. This condition led Mauriceau, Roederer, and nearly all of the earlier authorities to believe that from the fifth month onward the upper portion of the cervix gradually became obliterated and contributed to the enlargement of the uterine cavity, that which was left at the end of pregnancy representing merely its inferior end.

Stoltz, in 1826, stated that this doctrine was incorrect, and that the shortening was only apparent, being brought about by a fusiform dilatation of the cervical canal which resulted in the approach of the internal to the external os. He believed that the cervix retained its integrity until about two weeks before the onset of labor, when the canal slowly became obliterated and came to form part of the uterine cavity. Matthews Duncan accepted these views, but pointed out that they had been anticipated by the anatomical work of Verhegen, De Graaf, and Weitbrecht (1710-'50). At the same time he insisted upon certain modifications, holding that the cervical canal remained practically unchanged until the onset of labor. His statements soon received abundant confirmation from the observations of Holst, Müller, Lott, Taylor, Lusk, and many other investigators.

Müller pointed out that the apparent shortening of the cervix was due to the marked ante flexion of the uterus and the depression of the anterior fornix of the vagina by the presenting part, to which should be added the increased succulence of the entire genital tract. He also stated that the finger, at the end of pregnancy, could be introduced into the canal for a distance of 2.5 to 3 centimeters before it was arrested by the internal os. His conclusions were verified by further clinical observation, so that it is now generally admitted that in the great majority of cases the canal remains prac-

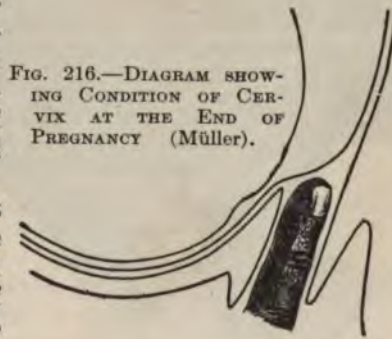


FIG. 216.—DIAGRAM SHOWING CONDITION OF CERVIX AT THE END OF PREGNANCY (Müller).



tically unaltered until the onset of labor, and that it may even be slightly longer than in the non-pregnant condition, thus indicating that the cervix shares somewhat in the general hypertrophy of the uterus.

In recent years the results obtained by examination during life have received additional confirmation from the study of frozen sections made through the bodies of women dying late in pregnancy. Valuable contributions along these lines have been made by Waldeyer, Schroeder, Braune and Zweifel, Pinard and Varnier, Leopold, and others.

#### Lower Uterine Segment.—

For a short time after the appearance of Müller's work in 1868, the question concerning the behavior of the cervix was regarded as practically settled; but these hopes were shattered in 1872 by the studies of Braune upon frozen sections made through a woman who had died during the second stage of labor. His specimen showed distinctly that the interior of the uterus was divided into two parts by a projecting circular ridge, 10 to 11 centimeters above the margins of the dilated external os, its situation being marked by a large vein, and by the deflection of the peritoneum from the anterior surface of the uterus (Fig. 220). The portion above it possessed thick walls, while the remainder appeared as a thin-walled, muscular tube through which the head had partially passed. Braune identified this ring or ridge with the internal os, and concluded that everything below it had been derived from the cervix; nor did he think it remarkable that the small canal which had existed up to the time of labor should have been converted into a structure of such dimensions.

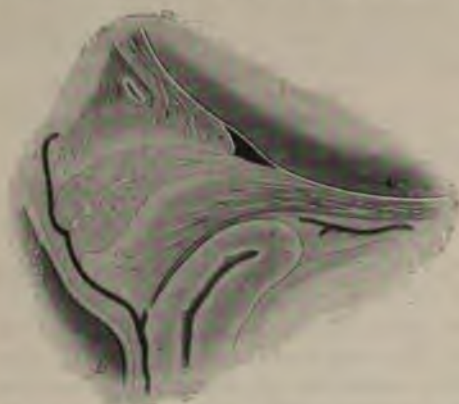


FIG. 217.—CERVIX AT THE END OF PREGNANCY (Waldeyer).  $\times \frac{1}{2}$ .



FIG. 218.—CERVIX AT THE END OF PREGNANCY (Braune and Zweifel).  $\times \frac{1}{2}$ .

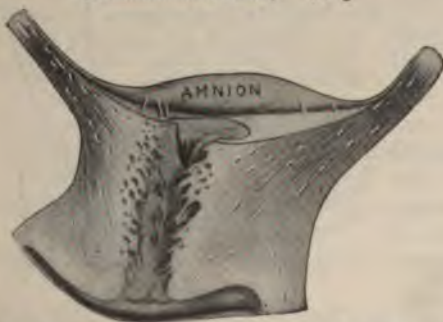


FIG. 219.—CERVIX AT THE END OF PREGNANCY, SHOWING PRESERVATION OF CANAL (Leopold).  $\times \frac{1}{2}$ .

Bandl, in his work upon rupture of the uterus, which appeared in 1875, pointed out that when such an accident occurs the point of rupture is nearly always situated below Braune's ring—namely, in the *lower uterine segment*. When he took up the subject the following year, he considered it inconceivable that the cervical canal, which was only 2.5 to 3.5 centimeters long at the end of pregnancy, could be converted in a few hours into the structure described by Braune. He therefore concluded that, if the upper boundary of the latter really represented the internal os, certain preparatory modifications must have taken place during the later part of pregnancy in order to make such a remarkable change possible. He believed that, during the last few weeks of pregnancy, the tissue forming the outer portion of the cervix was gradually shifted, so that it became incorporated with the musculature of the lower portion of the body of the uterus, while the cervical mucous membrane retained its original position. According to his view, then, the true internal os was situated not at the

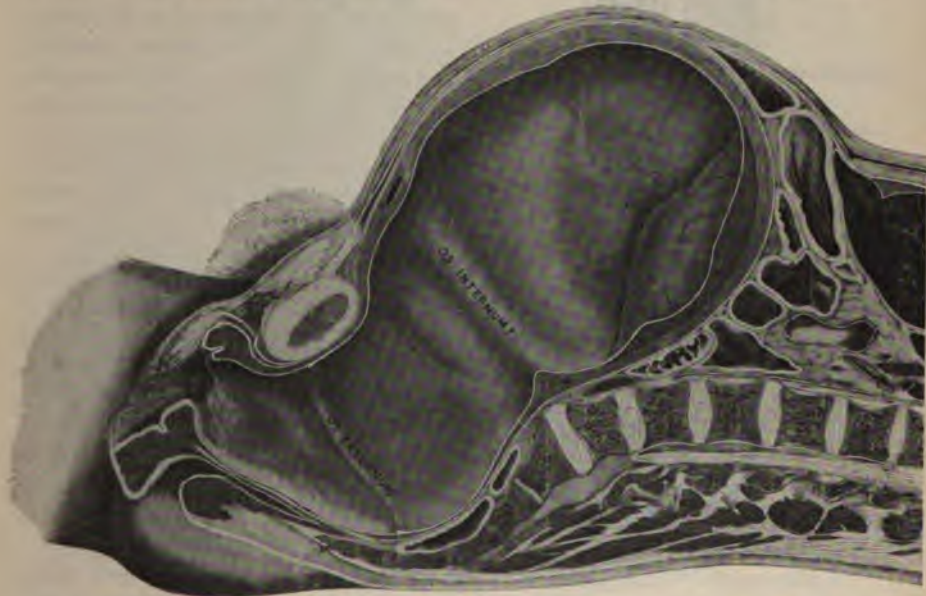


FIG. 220.—FROZEN SECTION THROUGH WOMAN DYING DURING SECOND STAGE OF LABOR, SHOWING CONTRACTION RING (Braune).

upper termination of the cervical mucosa, but much higher, and at a level corresponding to that of Braune's ring.

Although Bandl's complicated explanation is no longer accepted, his name will always have a place in the literature of the subject. More particularly, as we are indebted to him for our views concerning the clinical significance of the lower uterine segment, inasmuch as he was the first to distinguish clearly between the function of the upper contractile and active and of the lower passive segments of the uterus, as well as the relation which they bear to the occurrence of rupture.



The discussion started by Bandl has been responsible for an immense literature. Two main views have been advanced concerning the nature and origin of the passive segment of the uterus. According to the first, it is derived partly from the cervix, the internal os being supposed to be situated 3 or 4 centimeters above the external, while the rest of the structure—the lower uterine segment—is formed by the lower portion of the body of the uterus. According to the second view, the entire structure, from Braune's ring to the external os, is derived entirely from the cervix. The first view has received the indorsement of such authorities as Schroeder, Ruge, von Franqué, Barbour, and Veit, while the correctness of the second explanation is upheld by Bandl, Küstner, Bayer, Zweifel, Gräsel, and others. That the question is not yet settled is shown by the fact that Bumm and Blumreich, after studying a new frozen section in 1907, hold to the latter view; while Barbour is equally positive in stating that it is by no means of universal application.

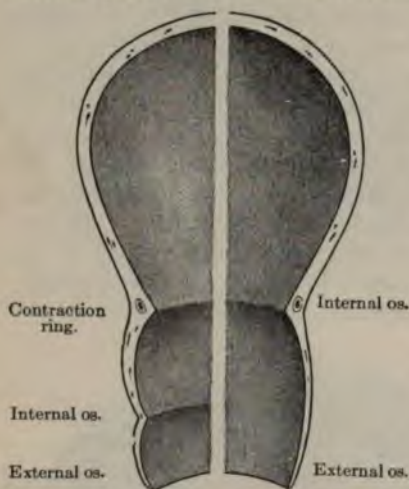


FIG. 221.—DIAGRAM ILLUSTRATING MAIN VIEWS AS TO NATURE OF LOWER UTERINE SEGMENT (American Text-Book).

ing that it is by no means of universal application.

At first glance it might appear strange that the question has given rise to such divergence of opinion, as it would seem a very simple matter to demonstrate the structure of the parts by microscopical examination. If the first view be correct, the inner surface of the portion which is supposed to be derived from the uterus should be lined by decidua, and the portion below it, corresponding to the cervical canal, by the characteristic cervical mucosa. On the other hand, if the second explanation is to be accepted, the entire structure below Braune's ring—the *contraction or retraction ring*, as it is variously designated—should be lined by cervical epithelium.

Unfortunately, the question is not so easily solved. In the first place, the formation of the structures in question is in great part a clinical phenomenon; and while the situation of the contraction ring can usually be definitely made out by the examining finger during labor, it is not so clearly marked after the removal of the uterus from the dead body. Again, the majority of the specimens which have been relied upon to settle the question were frozen before being subjected to microscopical examination, so that the finer histological details had become obliterated. In spite of these obstacles, however, the question has gradually approached a solution, and most investigators are inclined to believe that the first view is correct, except in occasional instances.

Moreover, Aschoff in 1906, and again in 1908, stated that a great part of the confusion is due to the fact that those taking part in the discussion

uated 3 or 4 centimeters above the external, while the rest of the structure—the lower uterine segment—is formed by the lower portion of the body of the uterus. According to the second view, the entire structure, from Braune's ring to the external os, is derived entirely from the cervix. The first view has received the indorsement of such authorities as Schroeder, Ruge, von Franqué, Barbour, and Veit, while the correctness of the second explanation is upheld by Bandl, Küstner, Bayer, Zweifel, Gräsel, and others. That the question is not yet settled is shown by the fact that Bumm and Blumreich, after studying a new frozen section in 1907, hold to the latter view; while Barbour is equally positive in stating

are not agreed as to what constitutes the cervix. He holds that a narrow portion, the isthmus, usually separates the uterine cavity from the cervical canal, and is lined by typical uterine mucosa. It is therefore apparent that those who designate its upper opening as the internal os must claim that the lower uterine segment is derived from the cervix; while those who place the internal os at the junction between the isthmus and cervical canal are likewise correct in holding that the passive portion of the uterus is derived both from its body and cervix. To obviate this difficulty, he proposes to designate the upper and lower openings of the isthmus, respectively, as the anatomical and histological internal os. The contraction ring corresponds to the former, while the lower uterine segment is derived from the tissue lying between it and the histological internal os.

Plate IX represents a vertical mesial section through the uterus of a woman, seven months pregnant, who died at the Johns Hopkins Hospital



FIG. 222.—MY FROZEN SECTION, SHOWING CONDITION OF THE BIRTH CANAL IN FIRST PART OF SECOND STAGE OF LABOR.  $\times \frac{1}{2}$ .

C.R., contraction ring; e.o., external os.

during premature labor. In this it is clearly seen that the external os is not dilated, but that the cervical canal has become obliterated and a distinct lower uterine segment has been formed. Careful examination shows that the latter is lined with a typical cervical mucous membrane for a distance of 3.5 to 4 centimeters from the margins of the external os, whereas above this point the tissue is distinctly uterine in appearance and is covered by decidua.

Fig. 222 represents part of a frozen section through a pregnant cadaver,



shown in Plate I, which was kindly placed at my disposal by Drs. J. Holmes Smith and L. E. Neale. The woman, who had a slightly generally contracted rachitic pelvis, died in labor with the membranes protruding from the vulva. The child presented by the breech, which had not yet become engaged. The cervical canal was obliterated and the external os fully dilated, its margins being 1 millimeter thick. There was no trace of the internal os. Seven centimeters above the external os was a well-marked contraction ring. Unfortunately, the specimen was so macerated that the lining membrane of the cervical canal and lower uterine segment had disappeared. Microscopical examination revealed only a few cervical glands in the neighborhood of the external os, but gave no information as to whether the portion below the contraction ring was lined by decidua or cervical epithelium.

Hofmeier, in 1886, demonstrated that the structure of the lower uterine segment is not homogeneous, and that the portion which corresponds to the cervix is composed of dense connective tissue rich in elastic fibers, while its upper part is made up of muscular lamellæ which pursue an almost parallel course, whereas as soon as the contraction ring is reached the uterine musculature takes on its characteristic appearance.

**Changes in the Uterus during the First Stage of Labor.**—Passing from these more or less theoretical considerations to the condition of the uterus at the onset of labor, we find that the organ is made up of two parts: a large, thin-walled, muscular sac—the body—to the lower end of which the small cervix is attached. The wall of the former rarely exceeds 5 millimeters in thickness, and is lined by decidua and the foetal membranes. The cervix is softened and very succulent. It presents a more or less fusiform canal, 3 to 4 centimeters long, which is bounded at its upper and lower ends by the internal and external os respectively; its walls rarely exceeding 1.5 centimeters in thickness. The condition of the external os varies considerably, according as the patient is a primiparous or multiparous woman. In the former it is quite tightly closed and barely admits the tip of the little finger; while in the latter it is widely gaping, so that the index finger can be readily passed through the funnel-shaped cervical canal up to the internal os.

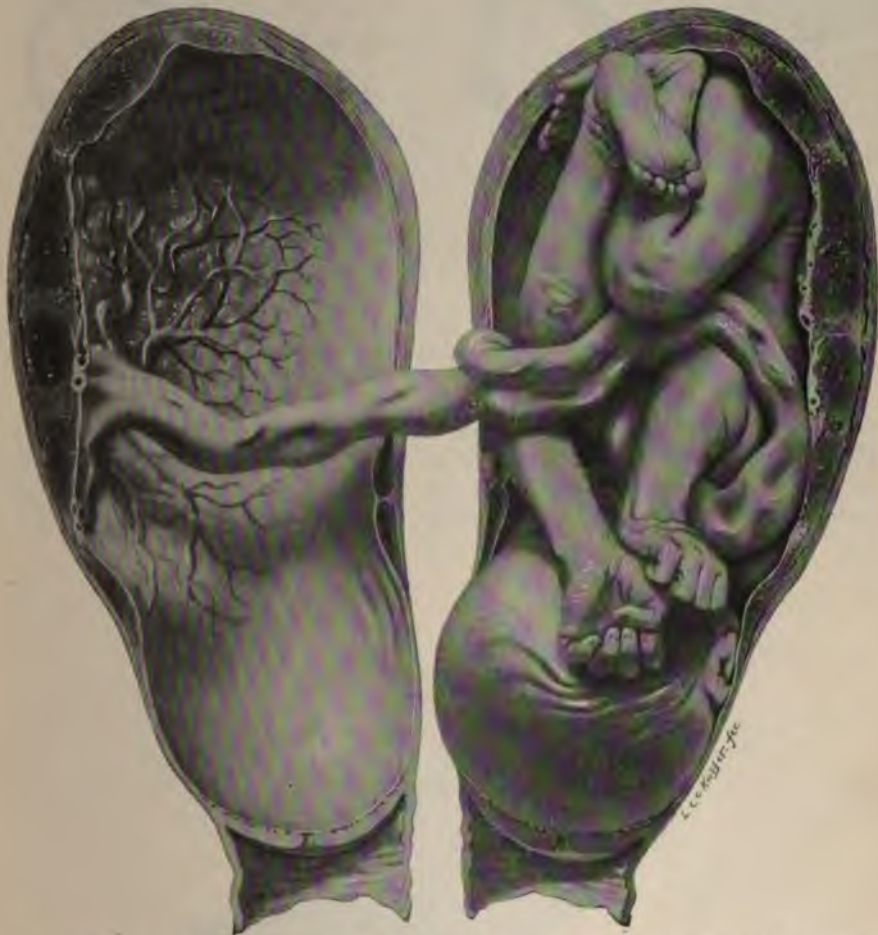


FIG. 223.—SECTION THROUGH LOWER UTERINE SEGMENT AND CERVIX, SHOWING RHOMBOIDAL ARRANGEMENT OF MUSCLE FIBERS IN FORMER AND DENSE STRUCTURE IN LATTER (Hofmeier).

P., peritoneal covering of uterus;  
o.e., os externum;  
o.i., os internum.

During labor, under the influence of the uterine contractions, the uterus becomes differentiated into two distinct portions, which are separated from one another by the contraction ring. The upper is the active contractile portion and becomes thicker as labor advances, while the lower plays a merely passive part, becoming converted into a

PLATE IX.



SEVEN AND A HALF MONTHS' PREGNANT UTERUS FROM WOMAN DYING  
IN THE FIRST STAGE OF LABOR.  $\times \frac{1}{2}$ .





thin-walled muscular tube for the transmission of the foetus (Fig. 225).

With the onset of labor pains the fluid contents of the uterus are subjected to pressure. As the lower uterine segment and the cervix will



Fig. 224.

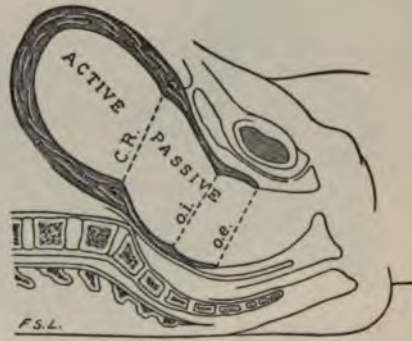


Fig. 225.

FIGS. 224, 225.—DIAGRAMS OF BIRTH CANAL AT END OF PREGNANCY AND DURING SECOND STAGE OF LABOR, SHOWING FORMATION OF BIRTH CANAL (Schroeder).

naturally constitute a point of least resistance, the fluid pressure, which is transmitted equally in all directions by the amniotic fluid, consequently gives rise to an increased tension and distention of these portions of the uterus. On abdominal palpation, even before the rupture of the mem-

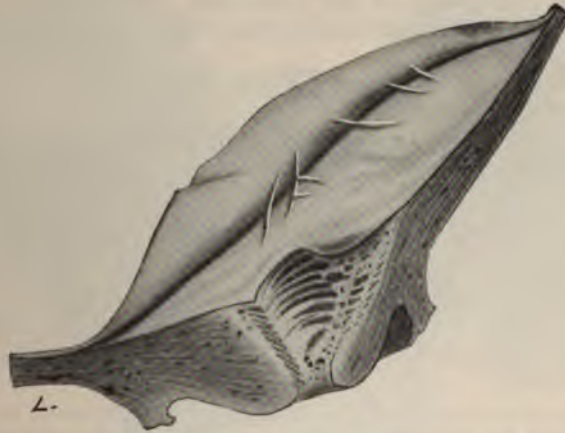


FIG. 226.—DILATATION OF CERVIX, FUNNEL-SHAPED OBLITERATION OF INTERNAL OS AND CERVICAL CANAL (Leopold).

branes, two zones can sometimes be differentiated during a contraction, the upper one of which is firm and hard, while the lower affords a semi-fluctuant sensation. The former represents the contractile portion of the uterus, the latter the passive lower uterine segment and cervix.

Again, since the cervix is perforated by its canal, the fluid pressure



exerted by the bag of waters tends to cause its obliteration and final dilatation, which is aided by the traction exerted upon its margins by the contracting fibers of the upper portion of the body of the uterus. When complete dilatation has been effected, the external os is about 10 centimeters



FIG. 227.—DILATATION OF CERVIX FURTHER ADVANCED THAN IN FIG. 226 (Leopold).  $\times 1$ .

in diameter, and its margins lie 8 to 10 centimeters below the contraction ring, while no trace of the internal os can be found. At the same time the bladder is gradually drawn up in front of the lower uterine segment until it becomes almost entirely an abdominal organ.

The *dilatation of the cervix* should be regarded as consisting of two stages: first, obliteration of the canal; and, second, dilatation of the external os. The obliteration occurs from above downward, the beginning



FIG. 228.—CERVICAL CANAL COMPLETELY OBLITERATED, EXTERNAL OS INTACT.  $\times 1$ .

being indicated by a funnel-shaped depression at the region of the internal os, which gradually increases in extent and depth until the entire canal has disappeared, when the uterine cavity is separated from the vagina merely by the external os. This is clearly shown in Figs. 226, 227, and

228, and also in Figs. 229, 230, 231, and 232, which represent reconstructions from the frozen sections of Schroeder, Winter, Säxinger, and Tibone, all of which were made through women who died during the first stage of labor.

After the cervical canal has become obliterated, dilatation of the external os occurs. In many instances its margins become extremely thin, and when tense gives a sensation as if they might cut the examining finger. This change is brought about almost entirely by the force exerted by the bag of waters, or, when that has ruptured prematurely, by the pressure of the presenting part itself.

The course of events differs considerably according as the woman is in her first or a subsequent pregnancy. In the former case marked resistance is offered by the external os, and a considerable time must elapse before complete dilatation is accomplished; whereas in the latter, the os is gaping



FIG. 229.—DILATATION OF CERVIX, FUNNEL-SHAPED OBLITERATION OF INTERNAL OS; CANAL 2 CENTIMETERS LONG (Schroeder).  $\times \frac{1}{2}$ .



FIG. 230.—DILATATION OF CERVIX, ALL BUT LOWER 10 MILLIMETERS OF CANAL OBLITERATED; EXTERNAL OS UNCHANGED (Winter).  $\times \frac{1}{2}$ .



FIG. 231.—DILATATION OF CERVIX, ALL BUT LOWER 3 MILLIMETERS OF CANAL OBLITERATED; EXTERNAL OS UNCHANGED (Säxinger).  $\times \frac{1}{2}$ .

and very little force is required for its complete dilatation after the cervical canal has become obliterated.

**Changes in the Uterus during the Second Stage of Labor.**—During the first stage of labor the contractions of the uterus have resulted in its differentiation into two parts, which are separated from one another by



the contraction ring. Above is the active, contractile portion, which becomes thicker as labor advances, and below the thin-walled, passive, lower uterine segment and cervix (Fig. 225).



FIG. 232.—DILATATION OF CERVIX, CANAL OBLITERATED; EXTERNAL OS 1.5 CENTIMETER IN DIAMETER. PLACENTA PRÆVIA (Tibone).  $\times \frac{1}{3}$ .

While these changes are being effected, there has been no advance on the part of the fœtus, and, as a rule, the presenting part occupies the same position from the onset of labor until complete dilatation of the cervix. With the commencement of the second stage, however, descent begins, and under normal conditions continues slowly but steadily until delivery is accomplished. Naturally, the differentiation into stages is more or less arbitrary, so that it occasionally happens that the presenting part begins to descend during the latter part of the first stage.

After it has brought about complete dilatation of the cervix, the bag of waters has served its function, and rupture usually now occurs, which is manifested by a sudden rush of a greater or lesser quantity of a tolerably clear fluid from the vagina. Occasionally the membranes give way some time before complete dilatation of the cervix has been brought about; whereas in rare instances they may retain their integrity until the completion of labor, so that the fœtus is born surrounded by them, the portion covering its head being designated as a *caul*.

We have already directed attention to the changes in shape which the uterus presents during contraction. These may be noticed in the first, but more especially in the second, stage, when the organ increases considerably in length, and at the same time diminishes in its transverse and antero-posterior diameters with each contraction. The increase in length is due partly to the stretching of the lower uterine segment, and partly to a straightening out of the fœtus; but we are unable to make definite statements as to its extent, for at present we possess no means of ascertaining how far the retraction of the upper portion of the uterus may serve to counterbalance the stretching of its lower segment. In obstructed labors, in which marked disproportion exists between the size of the present-



FIG. 233.—DIAGRAM SHOWING ACTION OF INTRA-UTERINE PRESSURE, MEMBRANES NOT RUPTURED.

ing part and the pelvic canal, the lower uterine segment is subjected to excessive stretching, and consequently the contraction ring assumes a much higher level, when it can be palpated as a distinct transverse or oblique ridge a short distance below the umbilicus. With the formation of the lower uterine segment, the upper portion of the uterus increases markedly in thickness, and, as labor proceeds, covers a progressively decreasing portion of the child. Thus, when the head is upon the perineum less than one-half of the foetus is in the upper segment.

**Forces Concerned in Labor.**—As long as the membranes are unruptured and the uterus contains a normal quantity of amniotic fluid—that is, during the entire first stage of labor, and, in the rare instances in which they remain intact, in the second stage—whatever force is exerted by the contracting uterus is transmitted to the liquor amnii, and by it to the foetus. In accordance with the laws of fluid pressure, therefore, it is applied with equal intensity to all portions of the child, and, were it not that the lower uterine segment and cervix represent the point of least resistance in the uterus, all its effect would be wasted; whereas, in the circumstances, it gives rise to the formation of the lower uterine segment and the dilatation of the cervix, but plays no part in causing the descent of the child. Attention was first directed to this point by Schatz and Lahs, and all subsequent authorities have accepted their conclusions.

After rupture of the membranes, a greater or lesser portion of the amniotic fluid escapes from the uterus, but in vertex presentations the presenting part usually acts as a fairly efficient tampon and causes the retention of a considerable quantity, which fills out the interstices between the foetus and the uterine walls. Lahs believed the amount retained was usually sufficient to prevent actual contact with the surface of the foetus, and that therefore extrusion of the latter was brought about by fluid pressure alone. He argued that under such circumstances (Fig. 234) the entire surface of the foetus, except the portion projecting through the cervix, would be subjected to fluid pressure, which, as it is equal in all directions, would exert no effect upon the foetus, except in a line passing through the center of the portion not subjected to it, thus manifesting itself as a downward force bringing about descent.

On the other hand, Lahs held that in all other presentations, as well as in those of the vertex when the amniotic fluid has almost completely drained off, other factors come into play which he regarded as distinctly pathological. In such cases the contracting uterus would come in direct contact with the surface of the foetus, and the force exerted by the fundus would be directly transmitted to the presenting part by way of the vertebral column.

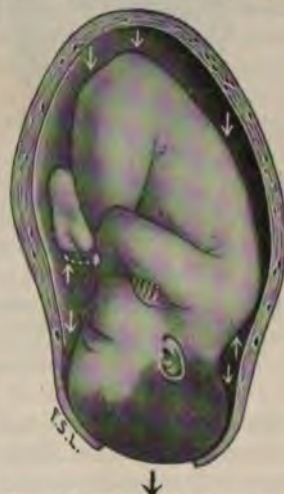


FIG. 234.—DIAGRAM SHOWING ACTION OF INTRA-UTERINE PRESSURE AFTER RUPTURE OF THE MEMBRANES.



Most recent writers have not hesitated to accept Lahs's interpretation, but Olshausen in 1901 directed attention to the fact that the latter force comes into play even in normal vertex presentations. He pointed out that only four frozen sections, through women dying in the second stage of labor, were available for the study of the question—namely, two of Braune and those of Chiari and Barbour—and that in three of them the fundus

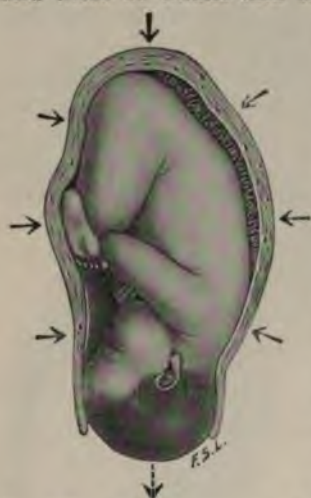


FIG. 235.—DIAGRAM SHOWING DIRECT PRESSURE EXERTED BY FUNDUS AFTER COMPLETE EVACUATION OF AMNIOTIC FLUID.

was in direct contact with the breech of the child. He then estimated that at least 300 cubic centimeters of amniotic fluid were required to fill out the interstices between the surface of the foetus and the uterine wall, and stated that the child could not be expelled solely by fluid pressure unless a greater quantity than this were present.

In 200 cases he measured the amount of amniotic fluid escaping when the child was born, which practically represents the quantity remaining in the uterus after rupture of the membranes, and found that in 80 per cent. of the primiparae it did not exceed 300 cubic centimeters; while in 60 per cent. it was not over 200 cubic centimeters, an amount by no means sufficient to fill out the interstices, let alone to separate the breech from the fundus, which is absolutely essential for the proper action of fluid pressure. He therefore concluded that in the circumstances

direct pressure must be exerted by the contracting uterus upon the breech, whence it is transmitted through the vertebral column to the head, and that this is rendered possible by the diminution in the transverse and antero-posterior diameter of the uterus, which results in an extension of the child and its conversion for the time being into a comparatively rigid object.

In addition to these factors, the contractions of the abdominal muscles of the woman also play no mean part in effecting the extrusion of the child; indeed, according to Schroeder, they alone bring it about. Olshausen, on the other hand, while not denying their importance, does not consider that they are the sole factors concerned. It is apparent, however, that their action is usually essential for the birth of the foetus, for when it is entirely absent, or only partially comes into play, labor is frequently so delayed that resort to forceps becomes necessary.

The descent of the presenting part is also partly due to the fact that the child becomes straightened out by the action of the pains during the second stage. According to Schroeder, its length from vertex to breech is increased by 5.5 centimeters as a result of this extension; while Olshausen considers that the increase is considerably greater, and estimates that it varies from 7.25 to 13 centimeters in 70 per cent. of the cases. Part of this, it is true, is counterbalanced by the greater length of the uterus, but the remainder is accounted for by the descent of the presenting part.

When the head has descended through the pelvis and is resting on the pelvic floor, more than half of the entire length of the child lies beneath the contraction ring; moreover, as the upper portion of the uterus becomes smaller and smaller, it necessarily exerts a diminished effect upon the child, so that, in the majority of cases, it becomes essential that the abdominal contractions should participate in the work.

Immediately after the birth of the child a marked change occurs in the position and size of the uterus, and on palpation it can be distinguished as a firm, rounded body which does not reach to the umbilicus. At this time its contracted and retracted body is freely movable above the collapsed lower uterine segment and cervix, and can readily be displaced in any desired direction.

**Changes in the Vagina and Pelvic Floor during Labor.**—The outlet of the pelvis is closed by a number of layers of tissue, which together constitute what is known as the pelvic floor. Beginning from within outward one meets successively with the peritoneum, the subperitoneal connective tissue, the internal pelvic fascia, the levator ani and coccygeus muscles, the external pelvic and perineal fascia, and, included between the latter, the superficial muscles of the perineum, external to which are the subcutaneous tissue and the cutaneous covering of the perineal and vulvar regions.

Of these structures the most important are the levator ani muscle and the fascia covering its upper and lower surfaces, which for practical purposes may be considered as constituting the pelvic floor. This muscle closes the lower end of the pelvic cavity as a diaphragm, and presents a concave upper and a convex lower surface. On either side it consists of a pubic and iliac portion; the former is a band 2 to 2.5 centimeters in width, which arises from the horizontal ramus of the pubis 3 to 4 centimeters below its upper margin, and 1 to 1.5 centimeters from the symphysis pubis. Its fibers pass backward and encircle the rectum, and possibly give off a few fibers which pass behind the vagina. The greater or iliac portion of the muscle arises on either side from the white line, the tendinous arch of the pelvic fascia, and from the ischial spine, at a distance of about 5 centimeters below the margin of the superior strait. Its fibers do not possess a uniform arrangement, but, according to the researches of Dickinson, the following portions can be distinguished: Passing from before backward, there is a narrow band which crosses the pubic portion and descends to the recto-vaginal septum. The greater part of the muscle passes backward and unites with that from the other side of the rectum, while the posterior portions meet together in a tendinous raphé in front of the coccyx, the most posterior fibers being attached to the bone itself. The muscle fails to fill out the posterior and lateral portions of the pelvic floor, which are occupied by the pyriformis and coccygeus muscles on either side.

The levator ani muscle varies from 3 to 5 millimeters in thickness, though its margins, which encircle the rectum and vagina, are somewhat thicker. It undergoes considerable hypertrophy during pregnancy, and on vaginal examination the internal margins of its pelvic portions can be felt as thick bands extending backward from the pubis, about 2 centimeters above the hymen. On contraction it serves to draw both the rectum and





FIG. 236.—THE PELVIC FLOOR SEEN FROM ABOVE (Kelly).



FIG. 237.—THE PELVIC FLOOR SEEN FROM BELOW (Kelly).

vagina forward and upward in the direction of the symphysis pubis, and is to be regarded as the real closer of the vagina, since the constrictor cunni, one of the superficial muscles of the peritoneum, is too delicate in structure to have more than an accessory function.

Although Farabeuf estimated that the levator ani upon contraction exerted a force of from 12 to 15 kilograms, it is generally believed that it is not sufficiently strong to afford support to the pelvic contents were it not reinforced by the strong pelvic fascia. Paramore in 1910 expressed a contrary view, but the prevailing opinion was well summarized by Eduard Martin in 1911. The internal pelvic fascia, which forms the upper covering of the levator ani, is attached to the margin of the superior strait, where it is joined by the fascia lining the iliac fossæ, as well as by the transverse

fascia of the abdominal walls. It passes down over the pyriformis and the upper half of the obturator internus muscle, and is firmly attached to the periosteum covering the lateral wall of the pelvis, the white line indicating its point of deflection from the latter, whence it spreads out over the upper surface of the levator ani and coccygeus muscles.

The inferior fascial covering of the pelvic diaphragm is divided into two parts by a line drawn

between the ischial tuberosities. Its posterior portion consists of a single layer which, taking its origin from the sacro-sciatic ligament and the ischial tuberosity, passes up over the inner surface of the ischial bones and the obturator internus muscles to the white line, in whose formation it

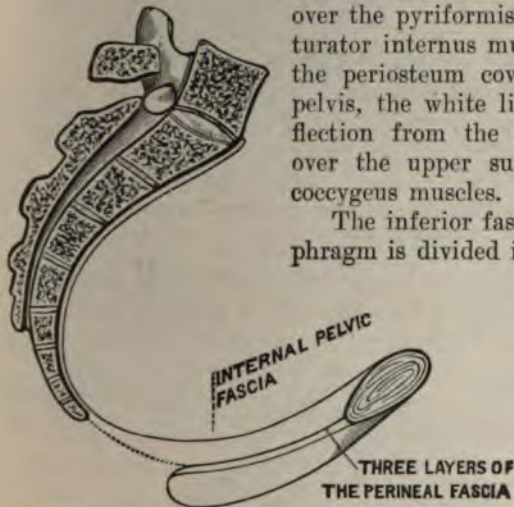


FIG. 238.—DIAGRAM SHOWING ARRANGEMENT OF PELVIC AND PERINEAL FASCIA (Tarnier).

takes part. From this tendinous structure it is reflected at an acute angle over upon the inferior surface of the levator ani, the space included between the latter and the lateral pelvic wall being designated as the ischio-rectal fossa. The structure filling out the space between the pubic arch and a line joining the ischial tuberosities is known as the urogenital diaphragm, which, exclusive of skin and subcutaneous fat, consists principally of three layers of fascia: (1) The deep perineal fascia which covers the anterior portion of the inferior surface of the levator ani muscle and is continuous with the fascia just described; (2) the middle perineal fascia which is separated from the former by a narrow space in which are situated the pudic vessels and nerves; (3) the superficial perineal fascia which, together with the layer just described, form a compartment in which lie the superficial perineal muscles, with the exception of the sphincter ani, the rami of the clitoris, the vestibular bulbs, and the vulvovaginal glands.



The superficial perineal muscles consist of the constrictor cunni, the ischio-cavernosus, and the transversus perinei muscles. These structures

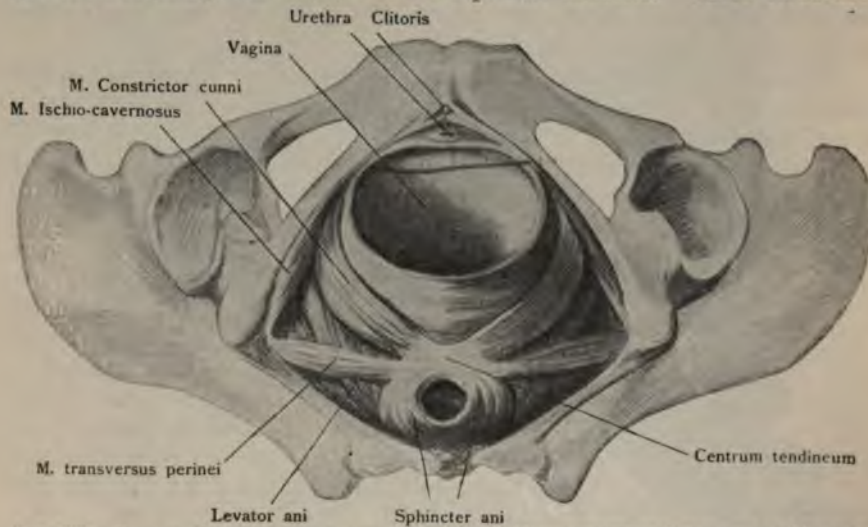


FIG. 239.—PELVIC FLOOR DISTENDED BY PRESENTING PART, SHOWING SUPERFICIAL MUSCLES OF PERINEUM (Budin).

are delicately formed and possess no obstetrical significance, except the last-named muscles, which are always torn through in perineal lacerations, when they serve in great part to bring about gaping of the wound. Stud-

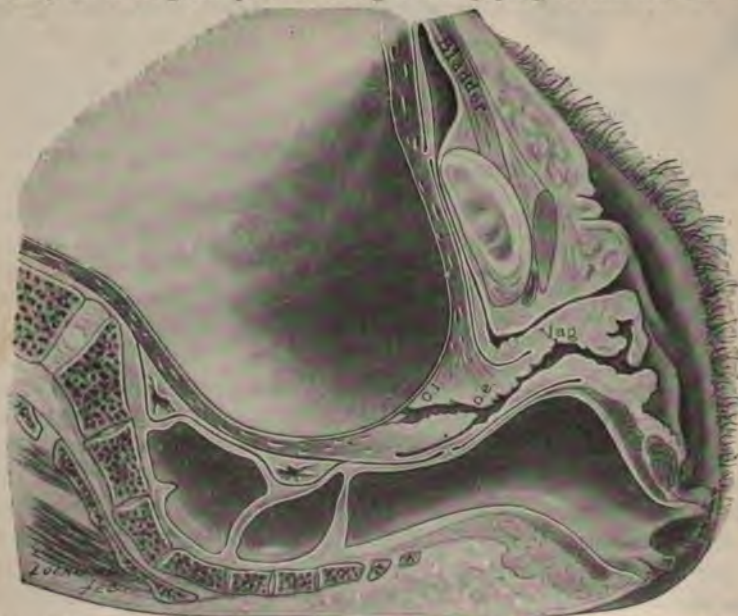


FIG. 240.—FROZEN SECTION, SHOWING CONDITION OF BIRTH CANAL IN LAST MONTH OF PREGNANCY (Braune and Zweifel).  $\times \frac{1}{2}$ .

diford holds that, anterior and interior to the sphincter ani, the perineal body contains numerous strands of non-striated muscle, which also play an important part in perineal tears.

In the first stage of labor the bag of waters takes part in the dilatation and distention of the upper portion of the vagina, but after its rupture the changes occurring in the pelvic floor are due entirely to the pressure

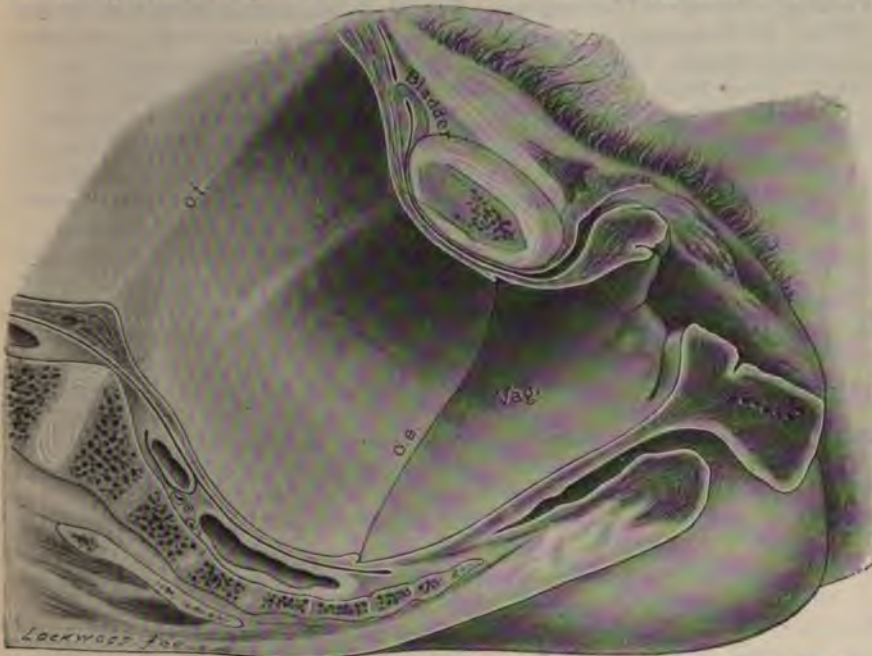


FIG. 241.—FROZEN SECTION, SHOWING CONDITION OF THE BIRTH CANAL IN FIRST PART OF SECOND STAGE OF LABOR (Braune).  $\times 4$ .

exerted by the presenting part. As this descends, the anterior portion of the pelvic floor becomes forced against the inferior and posterior portions of the symphysis. On the other hand, the posterior portion undergoes marked changes, becoming pushed downward and forward, and subjected to great stretching, eventually being converted into a thin-walled, tubular structure—the perineal gutter. Fig. 239 gives a good idea of the changes occurring in the pelvic floor, and demonstrates the important part played by the levator ani and the altogether insignificant function of the superficial perineal muscles. When the head distends the vulva, its opening looks upward and forward, and the course of the birth canal along the pelvic floor follows the curve indicated in Figs. 222 and 241.

Webster has pointed out that the most marked change consists in the stretching of the fibers of the levator ani muscle and the thinning of the central portion of the perineum, which becomes transformed from a wedge-shaped mass of tissue 5 centimeters in thickness to a thin, almost transparent membranous structure 2 to 4 millimeters thick. At the same time it is pushed down about 2.5 centimeters from its original position.



When the perineum is distended to the utmost, the anus becomes markedly dilated, and presents an opening which varies from 2 to 2.5 centimeters in diameter, through which the anterior wall of the rectum is seen to bulge.

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## CHAPTER XII

### MECHANISM OF LABOR IN VERTEX PRESENTATIONS

Vertex presentations occur in from 96 to 97 per cent. of all cases, and in them, as was first pointed out by Naegele, the sagittal suture nearly always engages in the right oblique diameter of the pelvis. In other words, one usually has to deal with a left occipito-anterior or a right occipito-posterior presentation. That this is so, and that the first-mentioned presentation is the one most frequently observed, practically all the authorities are agreed; but that wide differences of opinion exist as to the relative frequency of the several other varieties is clearly shown by the following table:

|              | Dubois in 1,913 cases. | Pinard in 500 cases. | The author in 1,687 cases. |
|--------------|------------------------|----------------------|----------------------------|
| L. O. A..... | 71 per cent.           | 52.6 per cent.       | 60.9 per cent.             |
| L. O. P..... | .63 "                  | 11 "                 | 2.6 "                      |
| R. O. A..... | 2.87 "                 | .2 "                 | 19.7 "                     |
| R. O. P..... | 25.6 "                 | 38.8 "               | 16.8 "                     |

**Mechanism in Left and Right Occipito-anterior Presentations.**—We shall consider in the first place the mechanism of labor in the anterior varieties of vertex presentations—namely, the left and right occipito-anterior.



FIG. 242.—DIAGRAM SHOWING CHILD  
IN L. O. A.



FIG. 243.—DIAGRAM SHOWING CHILD  
IN R. O. A.

**Diagnosis.**—The way in which the fœtus is presenting is most reliably determined by abdominal palpation, which can be utilized not only during pregnancy but also at the time of labor, provided it be practiced in the

intervals between the pains. Its accuracy, however, is markedly impaired in patients with very fat abdominal walls, or in whom the uterus is unduly distended by an excessive amount of amniotic fluid, or deformed by sub-

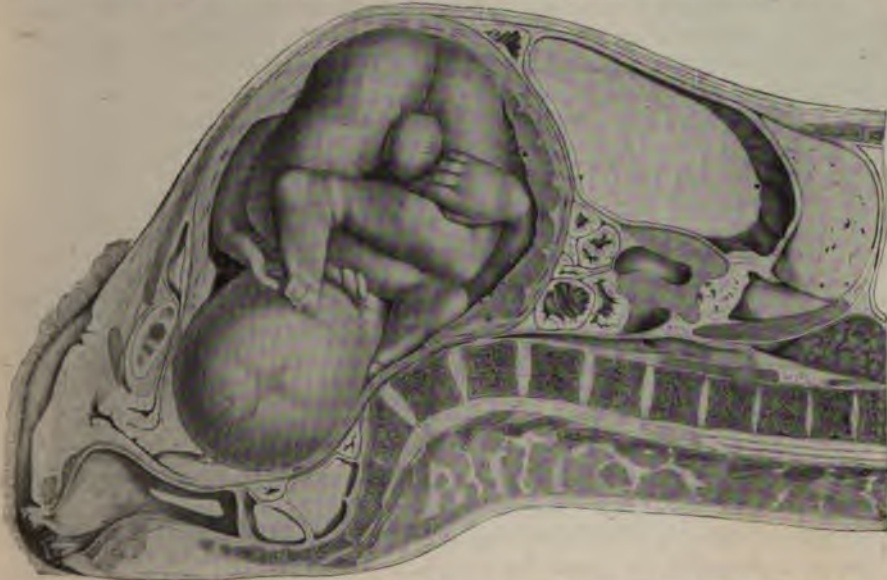


FIG. 244.—FROZEN SECTION THROUGH WOMAN AT END OF PREGNANCY, CHILD IN R. O. T. (Zweifel).

peritoneal or intramural myomata, as the latter may occasionally be mistaken for portions of the child.

For purposes of diagnosis we employ the four manœuvres already described, and with the foetus in the left occipito-anterior position obtain the following data:

- First manœuvre: Irregular breech at fundus.
- Second manœuvre: Resistant plane of back in the left and anterior portion of the abdomen, with the small parts on the right side.
- Third manœuvre: If the head be not engaged, it is felt as a freely movable body over the superior strait; but if it be fixed, the anterior shoulder may be detected.
- Fourth manœuvre: Negative if the head be not engaged; otherwise the cephalic prominence is felt on the right side (Plate X).

For the right occipito-anterior position the findings are as follows:

- First manœuvre: Irregular breech at fundus.
- Second manœuvre: Resistant plane of back in the right and anterior portion of the abdomen, with the small parts on the left side.
- Third manœuvre: As in L. O. A.
- Fourth manœuvre: Cephalic prominence on the left side.

Until the head has become engaged the information obtained by vaginal examination is extremely meager; and even after engagement satisfactory



results cannot usually be obtained until the cervix is sufficiently dilated to permit of the introduction of the finger, by which the various sutures and fontanelles are differentiated.

In the left anterior variety the sagittal suture occupies the right oblique diameter of the pelvis, with the small fontanelle in the neighborhood of the left ilio-pectineal eminence and the large fontanelle directed toward the right sacro-iliac synchondrosis. In the right anterior variety the sagittal suture occupies the left oblique diameter, the small fontanelle lying in the neighborhood of the right ilio-pectineal eminence, while the large fontanelle looks toward the left sacro-iliac synchondrosis.

The diagnostic value of vaginal examination may be still further impaired when the presence of a marked *caput succedaneum* makes it impossible to feel the sutures and fontanelles.

In the left anterior positions the foetal heart sounds are usually heard on the left side of the abdomen along a line joining the umbilicus and the left anterior-superior spine of the ilium; and in right positions at a corresponding point on the right side.

*Mechanism.*—Owing to the irregular shape of the pelvic canal and the relatively large dimensions of the mature foetal head, it is apparent that any portion of the latter, chosen at random, cannot necessarily pass through every plane of the former; hence, it follows that some process of adaptation or accommodation of suitable portions of the head to the various pelvic planes is necessary to insure the completion of childbirth. This is brought about by certain movements of the presenting part, which belong to what is termed the mechanism of labor.

For purposes of instruction, one is obliged to describe the various movements as if they occurred separately and independently of one another; whereas, in reality, the mechanism of labor consists of a combination of movements, several of which are going on at the same time, it being impossible for any one of them to occur without descent of the presenting part. These movements are divided into two classes, according as they are absolutely essential to the completion of labor, or as they merely facilitate its progress. To the first group belong the cardinal movements—*descent*, *internal rotation*, and *extension*; to the second the accessory movements—*flexion* and *external rotation*.

*Engagement.*—The mechanism by which the presenting part enters the superior strait is designated as engagement. This is best studied in women who have borne one or more children, for the reason that in primiparae the head normally descends into the pelvic canal some weeks before the onset of labor, when the most dependent portion of the presenting part lies just above a line joining the ischial spines; whereas in multiparous women this frequently does not occur until the commencement of labor pains.

In most multiparae at the end of pregnancy the head, which occupies a position midway between flexion and extension, is freely movable above the superior strait, or rests upon one or other iliac fossa. Accordingly, when the uterus begins to contract and to force it toward the pelvic opening, the cephalic circumference which first engages is the one that passes through the extremities of the fronto-occipital diameter. This normally

PLATE X.



First manœuvre.



Second manœuvre.



Third manœuvre.



Fourth manœuvre.

PALPATION IN LEFT OCCIPITO-ANTERIOR PRESENTATION.





measures 11.5 centimeters; and, as the conjugata vera is only 11 centimeters in length in the bony pelvis, and is encroached upon by various tissues in the living woman, it is apparent that a normal-sized head cannot engage with its sagittal suture directed antero-posteriorly. Accordingly, it must enter the superior strait either in the transverse or in one of its oblique diameters (12.75 centimeters). As has already been said, this usually occurs in the right oblique diameter, so that one end of the sagittal



FIG. 245.—POSITION OF FÆTUS BEFORE ENGAGEMENT.



FIG. 246.—POSITION OF FÆTUS AFTER ENGAGEMENT.

suture is directed toward the left ilio-pectineal eminence, and the other toward the right sacro-iliac synchondrosis. This is attributed to two factors. In the first place, the fœtus, in the later months of pregnancy, usually assumes this position spontaneously; and secondly, the posterior end of the left oblique diameter is encroached upon by the rectum; so that, for practical purposes, it is shorter than the right.

At first glance it may appear strange that the head does not engage in the transverse diameter of the pelvis, which measures 13.5 centimeters; but when one recalls the normal outlines of the superior strait (Figs. 247 and 248), it is seen that the promontory of the sacrum juts forward in such a manner as to make it difficult for engagement to occur in this way, as the available transverse diameter is considerably shorter than the oblique.

Prior to the middle of the eighteenth century little was known concerning the mechanism of labor, and it was generally thought that the head entered the pelvis with the sagittal suture directed antero-posteriorly. Fielding Ould in 1742 was the first to protest against such a view, and



within the following thirty years the observations of Smellie, Saxtorph, and Solayrès de Renhac demonstrated that enlargement occurred in the manner just described. It is true that Sentex, McKerron, Müller, and Liepmann have revived the older teachings, and have reported cases in which the head engaged with the small fontanelle either just behind the symphysis pubis or just in front of the promontory of the sacrum—occipitopubic or occipito-sacral presentation; but, inasmuch as under these circumstances labor is extremely difficult, it is evident that such an occurrence must be considered as distinctly pathological.

Nægele in 1838 held that engagement took place in such a way that the sagittal suture assumed an eccentric position, being nearer the promon-



Fig. 247.

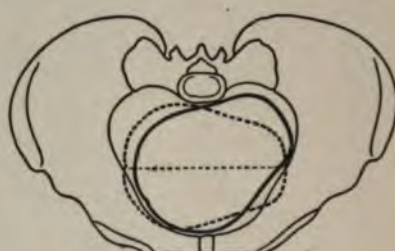


Fig. 248.

FIGS. 247, 248.—DIAGRAMS SHOWING WHY THE HEAD DOES NOT ENGAGE IN THE TRANSVERSE DIAMETER OF THE SUPERIOR STRAIT.

tory of the sacrum than the symphysis, and that therefore the anterior parietal bone of the fœtus was first felt on vaginal examination—*Nægele's obliquity*. Varnier, on the other hand, from the study of the various frozen sections at his disposal, concluded that the head entered the pelvis in an exactly opposite direction—namely, with its sagittal suture nearer the symphysis pubis, so that the posterior parietal bone was first felt on examination.

Neither of these views is quite correct when the pelvis is normal and the uterus not pendulous. The first presupposes that the axis of the uterus is to be found somewhat in front of that of the superior strait, and the second that it lies posterior to it. It would seem that Varnier overlooked the fact that the cadavers upon which his conclusions were based were frozen in the horizontal position, when the flaccid uterus would rest upon the vertebral column; but such conditions do not obtain in the living woman, in whom the uterus rises with each contraction, so that its long axis corresponds more or less closely with that of the superior strait. Moreover, careful vaginal examination reveals the fact that the head usually engages in such a manner that its sagittal suture lies either in the middle of the pelvis or approaches the promontory of the sacrum but slightly, and not by any means to the extent that Nægele had supposed. On the other hand, the condition of affairs noted by Varnier obtains only when considerable disproportion exists between the size of the head and the pelvis.

*Descent.*—The first requisite for the birth of the child is descent, which occurs continuously, though slowly, throughout labor, from the time the

head engages until its expulsion from the vagina. At the same time it should be remembered that the greater part of this movement is limited to the second stage of labor, when it is associated with the various movements to which reference will be made. Descent is brought about by four forces: (1) Intrauterine fluid pressure; (2) direct pressure of the fundus upon the breech; (3) contraction of the abdominal muscles, and (4) extension and straightening of the child's body.

As the anterior surface of the sacrum and the posterior surface of the symphysis measure 12 and 5 centimeters respectively, it is apparent that, if all parts of a body passing through the pelvic cavity are to reach the inferior strait at the same time, the one lying posteriorly must descend much more rapidly than the anterior portion. This compensatory difference in the rate of descent of the portions of the presenting part occupying the anterior and posterior segments of the pelvis is known as *synclitism*, and is clearly illustrated in Fig. 249.

*Flexion.*—As soon as the descending head meets with resistance, whether it be from the margins of the superior strait or the cervix, the walls of the pelvis or the pelvic floor, flexion results. In this movement the head rotates about its transverse axis in such a manner as to bring the chin into more intimate contact with the thorax, thereby substituting the suboccipito-bregmatic for the fronto-occipital diameter.

This purely mechanical phenomenon, by which a diameter of 9.5 replaces one of 11.75 centimeters, is due to the manner in which the head is articulated with the vertebral column, whereby the former becomes converted into a two-armed lever, the short arm extending from the occipital condyles to the occipital protuberance, and the long arm from the same point to the chin (Fig. 253). It is therefore apparent that when resistance is encountered the long arm of the lever, following the ordinary laws of mechanics, must ascend, while the short arm descends, and thus flexion is brought about.

The point of the birth canal at which this movement occurs varies greatly. When there is no disproportion between the presenting part and the pelvic canal flexion does not occur until the resistance of the pelvic floor is encountered, but if descent begins before the external os is fully



FIG. 249.—DIAGRAM ILLUSTRATING SYNCLITISM (Ahlfeld).



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dilated, especially if its margins are resistant, flexion may be completed before the head has left the uterus; while in generally contracted pelvises the



FIG. 250.—FROZEN SECTION, SECOND STAGE OF LABOR, CHILD IN R. O. A., MEMBRANES UNRUPTURED (Braune). Compare with Fig. 244.

movement occurs in an exaggerated manner while engagement is being effected.



Fig. 251.



Fig. 252.

FIGS. 251, 252.—DIAGRAMS SHOWING EFFECT OF FLEXION, CONVERSION OF OCCIPITO-FRONTAL INTO SUB-OCCIPITO-BREGMATIC DIAMETER.



FIG. 253.—DIAGRAM SHOWING HEAD LEVER (American Text-Book).

*Internal Rotation.*—By this is understood a turning of the head about its vertical axis in such a manner that the occiput gradually moves from

the position which it originally occupied toward the symphysis pubis or the hollow of the sacrum, as the case may be.

Internal rotation is absolutely essential for the completion of labor, except when the child is abnormally small, and in the anterior varieties always occurs from left to right in left positions, and in the reverse direction in right positions (Figs. 245 and 255). Indeed, no matter what the original position of the head may be, the occiput usually rotates to the front, although exceptionally, in occipito-posterior presentations, it may turn toward the hollow of the sacrum. It should be remembered that internal rotation does not occur by itself, but is always associated with the descent of the presenting part.

Various theories have been advanced in the attempt to explain the manner in which internal rotation is brought about, and a vast literature has



FIG. 254.—DIAGRAM SHOWING ANTERIOR ROTATION FROM L. O. A.

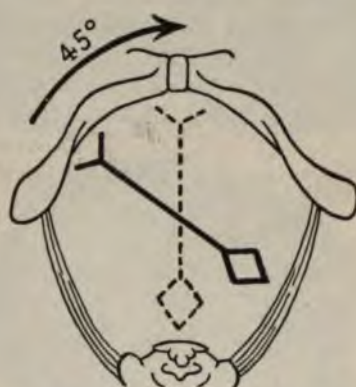


FIG. 255.—DIAGRAM SHOWING ANTERIOR ROTATION FROM R. O. A.

accumulated upon the subject, which was well reviewed by Paramore in 1909. Prior to the time of Ould and Smellie nothing was known concerning this movement, but afterwards it was believed that it was rendered necessary by the shape of the pelvic canal, it having been taught that the superior strait represented an ellipse whose long axis lay transversely, and the inferior strait one whose long axis was antero-posterior; so that for the head to descend it was necessary that its sagittal suture be directed transversely or obliquely to pass through the former, and antero-posteriorly to pass through the latter. A little consideration, however, will show that this is not the case, for, when the coccyx is displaced backward during labor, the inferior strait presents an almost circular opening, its transverse diameter being 11 and its antero-posterior 11.5 centimeters. Varnier is therefore justified in concluding that the shape of the pelvis alone does not explain the production of this movement; and, moreover, when we recall the fact that the suboccipito-frontal diameter of the head, which passes through it during expulsion, measures 10.5 centimeters (Fig. 256), it is evident that, unless some other factor rendered it necessary, the head could be born without internal rotation.



This factor is to be found in the structures of the pelvic floor, and particularly in the levator ani muscle, which, yielding before the impact of the head, nevertheless exerts sufficient force upon it to compel it to adjust itself to its curvatures. Furthermore, the walls of the perineal gutter offer a concave inclined plane over which the rounded head readily glides in its downward course.

This explanation, although fairly satisfactory when the occiput is originally directed obliquely anteriorly in the pelvis, would not necessarily seem to apply with equal force to those cases in which it occupies an obliquely posterior position. But the following account of Dubois's experiment clearly demonstrates that even in such circumstances the pelvic floor exerts a predominating influence in the production of this movement: "In a woman who had died a short time previously in childbed the uterus, which had remained flaccid and of large size, was opened up as far as the cervical orifice and held by assistants in a suitable position above the superior strait. The foetus of the woman was then placed in the soft and dilated uterus in the right occipito-posterior position. Several pupil-midwives, pushing the foetus from above, readily caused it to enter the cavity of the pelvis. Much greater force

was needed to make the head travel over the perineum and clear the vulva, and it was not without astonishment that we saw, in three successive attempts, that, when the head had traversed the external genital organs, the occiput had turned to the right anterior position, while the face was turned to the left and to the rear. In a word, rotation had taken place as in natural labor. We repeated the experiment a fourth time, but as the head cleared the vulva the occiput remained posterior. We then took a



FIG. 256.—DIAGRAM SHOWING SUBOCCIPITO-BREGMATIC, SUBOCCIPITO-FRONTAL, AND OCCIPITO-FRONTAL DIAMETERS.

dead-born foetus of the previous night, but of much larger size than the preceding, and placed it in the same position as the first, and twice in succession witnessed the head clear the vulva after having executed the movement of rotation. Upon the third and following essays delivery was accomplished without the occurrence of rotation. Thus the movement only ceased after the perineum and vulva had lost the resistance which had made it necessary, or at least had been the inciting cause of its accomplishment."

From Solayrès de Renhac (1771) to the present time, many authors, among whom may be mentioned Scanzoni, Hodge, and Reynolds, have sought to explain the production of rotation by calling attention to the shape of the pelvic canal, and pointing out that the inclination of its walls—the *inclined planes of the pelvis*—serves to direct the occiput anteriorly. By others it was thought that the projecting ischial spines also played a

lar part by interposing an obstacle to posterior rotation.

Schroeder believed that the movement was inaugurated by the body of the child rotating in such a way as to bring its back more to the front, and that the head followed it. He considered that this was brought about by an attempt on the part of the uterus to assume its normal flattened shape,



FIG. 257.—FROZEN SECTION THROUGH WOMAN IN LABOR WITH CHILD PARTLY DELIVERED, SHOWING COMPLETE EXTERNAL ROTATION OF THE HEAD AND IMPERFECT ROTATION OF THE SHOULDERS (Zweifel).

as its contents were expelled. He did not believe that the shoulders were rotated into a directly transverse position, but considered that they remained somewhat behind the occiput—30 degrees, according to Schatz—



FIG. 258.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

and that the movement of the body merely inaugurated that of the head, which was still further accentuated by accessory causes.

Olshausen and Bumm argued in favor of this theory, but do not seem



to have adduced any additional evidence in its support. Furthermore, it fails to explain the rotation of the shoulders into the antero-posterior diameter of the outlet after the delivery of the head, as this movement must be attributed to factors identical with those causing internal rotation of the head. On the other hand, the frozen section of Zweifel, through a woman who had died just after the birth of the child's head, shows that the latter had undergone complete external rotation, while the shoulders had not rotated so as to occupy the anterior-posterior diameter of the outlet, thus indicating that the body does not inaugurate rotation of the head in this stage of the mechanism of labor.

In 1906 Sellheim made an important contribution to the subject. He held that internal rotation is the inevitable consequence of a definite physical law. According to which, whenever a cylindrical body of suitable



FIG. 259.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

size, which can be bent to a different extent in several locations, is forced through a curved cylindrical canal, it must necessarily rotate until the portion which is most readily bent adapts itself to the curvature of the canal. By studying newly born children, he demonstrated that in vertex presentations such bending occurs most readily in the cervical region, and tends to bring about extension, while in face presentations it occurs in the opposite direction and brings about flexion. Accordingly, in the former rotation must take place until the posterior portion of the neck adapts itself to the "knee" of the birth canal, while in the latter the anterior portion of the neck must become so adapted, thus causing the occiput or chin to rotate anteriorly, as the case may be.

By a series of ingenious experiments with models of the child and birth canal, he has shown that rotation always occurs in accordance with this law, no matter in what position the presenting part may be introduced into the upper part of the canal, thereby also explaining the mechanism of rotation in posterior positions. Unfortunately, even if Sellheim's rea-

soning is correct, his explanation has only carried us one step further forward, and still leaves us in ignorance of the ultimate cause of the movement.

*Extension.*—When, after internal rotation, the sharply flexed head reaches the vulva, it undergoes another movement which is absolutely essential to its birth—namely, it becomes extended so that the base of the occiput comes in direct contact with the inferior margin of the symphysis pubis. This movement is brought about by two factors. In the first place, as the vulval outlet looks upward and forward, extension must occur before the head can pass through it. For if the sharply flexed head, on reaching the pelvic floor, continued to be driven downward in the same direction as heretofore—in the axis of the superior strait—it would impinge upon the end of the sacrum and the posterior portion of the perineum,



FIG. 260.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

and, if the *vis a tergo* were sufficiently strong, would eventually be forced through the perineal tissues. But when the head presses upon this structure, two forces come into play, the first acting downward, exerted by the uterus, and the second upward, supplied by the resistant pelvic floor, the resultant force being one directed forward and somewhat upward in the direction of the vulval opening, thereby giving rise to extension. Joseph Jones in 1906 directed attention to the fact that the movement of extension does not occur merely at the articulation between the occiput and atlas, but is preceded and inaugurated by an extension of the entire cervical region. He holds that such a movement brings about a marked change in the manner in which the force exerted by the uterus is transmitted to the occiput, and likens it to the interposition of the crank shaft between the end of the piston and the wheel of an engine.

After the suboccipital region has come in contact with the inferior margin of the symphysis pubis, the head is no longer to be regarded as a two-armed, but simply as a one-armed lever, the occiput being the fulcrum



with the arm extending from it to the chin, so that any force exerted upon the head must necessarily lead to farther extension. As this becomes marked, the vulval opening gradually dilates and the scalp of the child soon becomes apparent through it. Now, if we mark the point which first appears, and carefully examine the child after its birth, we find in left occipito-anterior presentations that it was the upper and posterior margin of the right parietal bone that first came into view, while the reverse holds good in right occipito-anterior positions.

With increasing distention of the perineum and vaginal opening, a larger and larger portion of the occiput gradually appears, and the head is born by further extension, the occiput, bregma, forehead, nose, mouth, and finally the chin successively passing over the anterior margin of the perineum. Immediately after its birth the head falls downward and the chin comes in contact with the region of the anus.

*External Rotation.*—A few moments after its birth the head undergoes another movement, and, when the occiput has been originally directed toward the left, it rotates toward the left tuber ischii, and in the opposite direction when it has been originally toward the right. This is known as external rotation or restitution, and is simply the index of a corresponding rotation of the body of the child, which serves to bring its bisacromial diameter into relation with the antero-posterior diameter of the pelvic outlet. This movement is brought about by essentially the same factors which produce the internal rotation of the head.

*Expulsion.*—Almost immediately after the occurrence of external rotation, the anterior shoulder appears under the symphysis pubis, and in a short time the anterior portion of the perineum becomes distended by the posterior shoulder, which is first born, being rapidly followed by the other. Finally, the body of the child is quickly extruded along a curved line corresponding to the axis of the lower part of the birth canal—that is, with its upper side markedly concave and its lower convex.

✍ **Mechanism in Right and Left Occipito-posterior Presentations.**—In 1,687 cases of labor at the Johns Hopkins Hospital we observed 283 occipito-posterior presentations (16.8 per cent.), the occiput being directed to the right in 239 cases, and to the left in 44 cases, a proportion of about 1 to 5. The number of primary occipito-posterior positions was actually greater than here indicated, but, owing to the fact that many of our patients were not examined until well advanced in labor, it happened in many cases that anterior rotation had already occurred.

*Diagnosis.*—Palpation in a right occipito-posterior presentation gives the following data:

First manœuvre: The fundus is occupied by the breech.

Second manœuvre: The resistant plane of the back is felt well back in the right flank, the small parts being on the left side and in front and much more readily palpable than in anterior presentations.

Third manœuvre: Negative if the head is engaged; otherwise the movable head is detected above the superior strait.

Fourth manœuvre: Cephalic prominence on the left side (Plate XI).

PLATE XI.



First manœuvre.



Second manœuvre.



Third manœuvre.



Fourth manœuvre.

PALPATION IN RIGHT OCCIPITO-POSTERIOR PRESENTATION.





Whenever the back of the child is felt on the right side of the mother, the possibility of a right posterior position should always be borne in mind, as it usually occurs much more frequently than the right anterior variety. It should also be remembered, whenever the small parts are distinctly felt in the anterior portion of the abdomen, that one has in all probability to deal with a posterior position, more especially in the rare instances in which the occiput has rotated into the hollow of the sacrum. In the less frequent left posterior positions palpation gives similar results, except that the back is felt in the left flank, and the small parts and cephalic prominence are found on the right side of the abdomen.

On vaginal touch in the right posterior position, the sagittal suture occupies the right oblique diameter, the small fontanelle is felt opposite



FIG. 261.—DIAGRAM SHOWING CHILD IN L. O. P.

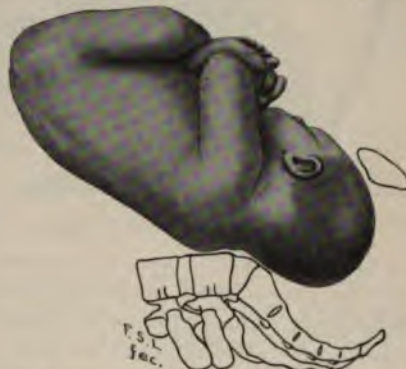


FIG. 262.—DIAGRAM SHOWING CHILD IN R. O. P.

the right sacro-iliac synchondrosis, the large fontanelle being directed toward the left ilio-pectineal eminence; while in the left position the reverse obtains. In many cases, particularly in the early part of labor, owing to imperfect flexion of the head, the large fontanelle lies at a lower level than in anterior positions, and is more readily felt.

On auscultation the heart is heard in the right or left flank of the mother, according as one has to deal with a right or left position. But it should be remembered that in the right posterior position the heart sounds are occasionally transmitted through the thorax of the child, and are best heard either in the middle line or slightly to the left of it. This is due to a partial extension of the head and the altered relation of the body of the child, whereby the thorax comes in contact with the anterior uterine wall.

*Mechanism.*—In about 90 per cent. of occipito-posterior presentations the mechanism of labor is identical with that observed in the anterior varieties, except that the occiput has to rotate from the region of the sacro-iliac synchondrosis to the symphysis pubis, instead of from the ilio-pectineal eminence—through 135 degrees instead of 45 degrees (Figs. 263 and 264).

Not infrequently internal rotation does not take place until the perineum begins to bulge, but occasionally it does not occur at all, or only par-



to have adduced any additional evidence in its support. Furthermore, it fails to explain the rotation of the shoulders into the antero-posterior diameter of the outlet after the delivery of the head, as this movement must be attributed to factors identical with those causing internal rotation of the head. On the other hand, the frozen section of Zweifel, through a woman who had died just after the birth of the child's head, shows that the latter had undergone complete external rotation, while the shoulders had not rotated so as to occupy the anterior-posterior diameter of the outlet, thus indicating that the body does not inaugurate rotation of the head in this stage of the mechanism of labor.

In 1906 Sellheim made an important contribution to the subject. He held that internal rotation is the inevitable consequence of a definite physical law. According to which, whenever a cylindrical body of suitable



FIG. 259.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

size, which can be bent to a different extent in several locations, is forced through a curved cylindrical canal, it must necessarily rotate until the portion which is most readily bent adapts itself to the curvature of the canal. By studying newly born children, he demonstrated that in vertex presentations such bending occurs most readily in the cervical region, and tends to bring about extension, while in face presentations it occurs in the opposite direction and brings about flexion. Accordingly, in the former rotation must take place until the posterior portion of the neck adapts itself to the "knee" of the birth canal, while in the latter the anterior portion of the neck must become so adapted, thus causing the occiput or chin to rotate anteriorly, as the case may be.

By a series of ingenious experiments with models of the child and birth canal, he has shown that rotation always occurs in accordance with this law, no matter in what position the presenting part may be introduced into the upper part of the canal, thereby also explaining the mechanism of rotation in posterior positions. Unfortunately, even if Sellheim's rea-

soning is correct, his explanation has only carried us one step further forward, and still leaves us in ignorance of the ultimate cause of the movement.

*Extension.*—When, after internal rotation, the sharply flexed head reaches the vulva, it undergoes another movement which is absolutely essential to its birth—namely, it becomes extended so that the base of the occiput comes in direct contact with the inferior margin of the symphysis pubis. This movement is brought about by two factors. In the first place, as the vulval outlet looks upward and forward, extension must occur before the head can pass through it. For if the sharply flexed head, on reaching the pelvic floor, continued to be driven downward in the same direction as heretofore—in the axis of the superior strait—it would impinge upon the end of the sacrum and the posterior portion of the perineum,



FIG. 260.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

and, if the *vis a tergo* were sufficiently strong, would eventually be forced through the perineal tissues. But when the head presses upon this structure, two forces come into play, the first acting downward, exerted by the uterus, and the second upward, supplied by the resistant pelvic floor, the resultant force being one directed forward and somewhat upward in the direction of the vulval opening, thereby giving rise to extension. Joseph Jones in 1906 directed attention to the fact that the movement of extension does not occur merely at the articulation between the occiput and atlas, but is preceded and inaugurated by an extension of the entire cervical region. He holds that such a movement brings about a marked change in the manner in which the force exerted by the uterus is transmitted to the occiput, and likens it to the interposition of the crank shaft between the end of the piston and the wheel of an engine.

After the suboccipital region has come in contact with the inferior margin of the symphysis pubis, the head is no longer to be regarded as a two-armed, but simply as a one-armed lever, the occiput being the fulcrum



with the arm extending from it to the chin, so that any force exerted upon the head must necessarily lead to farther extension. As this becomes marked, the vulval opening gradually dilates and the scalp of the child soon becomes apparent through it. Now, if we mark the point which first appears, and carefully examine the child after its birth, we find in left occipito-anterior presentations that it was the upper and posterior margin of the right parietal bone that first came into view, while the reverse holds good in right occipito-anterior positions.

With increasing distention of the perineum and vaginal opening, a larger and larger portion of the occiput gradually appears, and the head is born by further extension, the occiput, bregma, forehead, nose, mouth, and finally the chin successively passing over the anterior margin of the perineum. Immediately after its birth the head falls downward and the chin comes in contact with the region of the anus.

*External Rotation.*—A few moments after its birth the head undergoes another movement, and, when the occiput has been originally directed toward the left, it rotates toward the left tuber ischii, and in the opposite direction when it has been originally toward the right. This is known as external rotation or restitution, and is simply the index of a corresponding rotation of the body of the child, which serves to bring its bisacromial diameter into relation with the antero-posterior diameter of the pelvic outlet. This movement is brought about by essentially the same factors which produce the internal rotation of the head.

*Expulsion.*—Almost immediately after the occurrence of external rotation, the anterior shoulder appears under the symphysis pubis, and in a short time the anterior portion of the perineum becomes distended by the posterior shoulder, which is first born, being rapidly followed by the other. Finally, the body of the child is quickly extruded along a curved line corresponding to the axis of the lower part of the birth canal—that is, with its upper side markedly concave and its lower convex.

**Mechanism in Right and Left Occipito-posterior Presentations.**—In 1,687 cases of labor at the Johns Hopkins Hospital we observed 283 occipito-posterior presentations (16.8 per cent.), the occiput being directed to the right in 239 cases, and to the left in 44 cases, a proportion of about 1 to 5. The number of primary occipito-posterior positions was actually greater than here indicated, but, owing to the fact that many of our patients were not examined until well advanced in labor, it happened in many cases that anterior rotation had already occurred.

*Diagnosis.*—Palpation in a right occipito-posterior presentation gives the following data:

First manœuvre: The fundus is occupied by the breech.

Second manœuvre: The resistant plane of the back is felt well back in the right flank, the small parts being on the left side and in front and much more readily palpable than in anterior presentations.

Third manœuvre: Negative if the head is engaged; otherwise the movable head is detected above the superior strait.

Fourth manœuvre: Cephalic prominence on the left side (Plate XI).

PLATE XI.



First manœuvre.



Second manœuvre.



Third manœuvre.



Fourth manœuvre.

PALPATION IN RIGHT OCCIPITO-POSTERIOR PRESENTATION.





Whenever the back of the child is felt on the right side of the mother, the possibility of a right posterior position should always be borne in mind, as it usually occurs much more frequently than the right anterior variety. It should also be remembered, whenever the small parts are distinctly felt in the anterior portion of the abdomen, that one has in all probability to deal with a posterior position, more especially in the rare instances in which the occiput has rotated into the hollow of the sacrum. In the less frequent left posterior positions palpation gives similar results, except that the back is felt in the left flank, and the small parts and cephalic prominence are found on the right side of the abdomen.

On vaginal touch in the right posterior position, the sagittal suture occupies the right oblique diameter, the small fontanelle is felt opposite

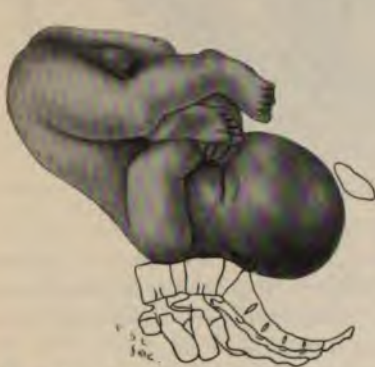


FIG. 261.—DIAGRAM SHOWING CHILD IN L. O. P.

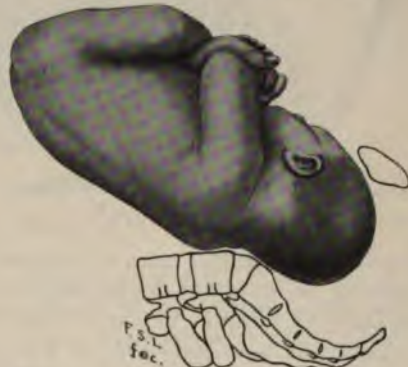


FIG. 262.—DIAGRAM SHOWING CHILD IN R. O. P.

the right sacro-iliac synchondrosis, the large fontanelle being directed toward the left ilio-pectineal eminence; while in the left position the reverse obtains. In many cases, particularly in the early part of labor, owing to imperfect flexion of the head, the large fontanelle lies at a lower level than in anterior positions, and is more readily felt.

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*Mechanism.*—In about 90 per cent. of occipito-posterior presentations the mechanism of labor is identical with that observed in the anterior varieties, except that the occiput has to rotate from the region of the sacro-iliac synchondrosis to the symphysis pubis, instead of from the ilio-pectineal eminence—through 135 degrees instead of 45 degrees (Figs. 263 and 264).

Not infrequently internal rotation does not take place until the perineum begins to bulge, but occasionally it does not occur at all, or only par-



tially, so that the occiput remains obliquely posterior, or rotates only to a transverse position. In either event spontaneous labor is out of the question unless the child is very small. Even in favorable cases considerable time is usually required for the completion of anterior rotation, so that there results a definite prolongation of labor. Varnier, upon comparing

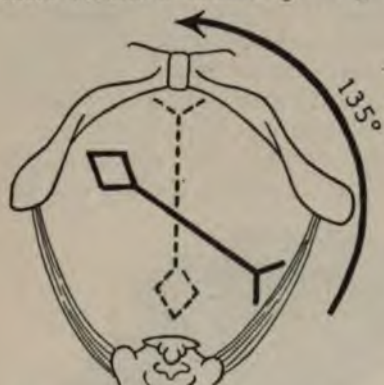


FIG. 263.—DIAGRAM SHOWING ANTERIOR ROTATION FROM L. O. P.

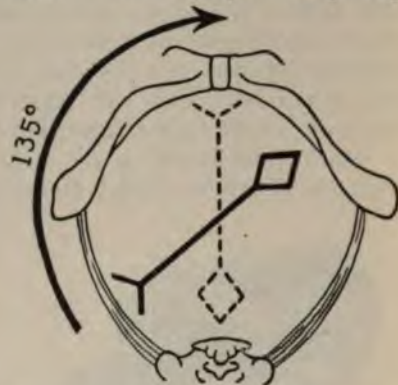


FIG. 264.—DIAGRAM SHOWING ANTERIOR ROTATION FROM R. O. P.

the histories in 400 cases of occiput posterior and in 660 cases of occiput anterior presentation, found that, in the former, labor averaged three hours and sixteen minutes to one hour and fifty minutes longer, according as the patient was a primiparous or multiparous woman.

In a small percentage of cases the occiput, instead of rotating anteriorly, or retaining its original position, turns toward the sacrum, so that it eventu-



FIG. 265.—DIAGRAM SHOWING POSTERIOR ROTATION FROM L. O. P.

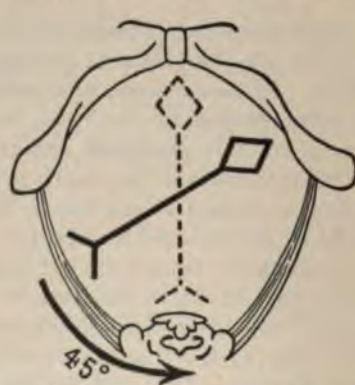


FIG. 266.—DIAGRAM SHOWING POSTERIOR ROTATION FROM R. O. P.

ally occupies its concavity. According to West this occurs in 3 per cent. of the cases, while Varnier and the writer have noted it in 2 per cent. and 7 per cent. respectively. Harrar, in 41,800 labors in all presentations, noted 1,446 "persistent occiput-posterior cases"—3.46 per cent. Of these 1,013 were delivered spontaneously with the occiput directly posterior, while 433

demanding operative interference, but it is not clear from his statement in what proportion of the latter the occiput remained obliquely posterior (R. O. P. or L. O. P.), or had rotated into the hollow of the sacrum (O. P.).



FIG. 267.—USUAL MECHANISM OF DELIVERY OF HEAD WITH OCCIPUT IN HOLLOW OF SACRUM.

In many instances it is difficult to explain why anterior rotation fails to occur, but it may be stated as a general rule that it is much more likely to take place when the head is well flexed than when it is imperfectly flexed or partially extended. In the latter event the large fontanelle occu-



FIG. 268.—USUAL MECHANISM OF DELIVERY OF HEAD WITH OCCIPUT IN HOLLOW OF SACRUM.

pies a lower level than the small, whence it would appear that the portion of the head which remains lowest is usually the one which rotates anteriorly.

After the occiput has rotated into the hollow of the sacrum, the child



may be born in one of two ways. Ordinarily the head becomes markedly flexed and lengthened in its mento-occipital diameter and eventually the region just anterior to the large fontanelle impinges upon the lower margin of the symphysis pubis, after which the occiput is slowly pushed over the anterior margin of the perineum by a movement of flexion. Then by a movement of extension the occiput falls backward, and the brow, nose, mouth, and chin appear successively under the symphysis. After the birth of the head, external rotation and expulsion of the body occur in the usual manner.

According to Sentex, Winckel, Weiss, and Müller, the head is occasionally born by another mechanism, which comes into play in those cases in which partial extension persists. In such circumstances the brow appears at the vulva, and, while the root of the nose impinges upon the symphysis, by a movement of flexion the brow, bregma, and occiput successively pass over the perineum, until finally the face slips out from under the symphysis pubis. This mechanism approaches closely to that observed in brow presentations, and is much more difficult than the one just considered, and is more liable to lead to tears of the maternal soft parts, since it is evident that in the first instance the vulva is distended by the sub-occipito-frontal diameter of the head, and in the second by the occipito-frontal, which measure respectively 10.5 and 11.75 centimeters.

It is generally believed that occipito-posterior offer a much more gloomy prognosis than occipito-anterior presentations. This is probably due to the fact that Mauriceau, Smellie, and all the early authorities taught that in such cases the occiput always rotated into the hollow of the sacrum. It is true that Naegele showed that posterior rotation was only of exceptional occurrence, and that in the vast majority of cases the occiput rotated anteriorly. But, in spite of his teachings, the older views still prevailed. Thus Capuron, in 1833, taught that spontaneous delivery could not take place; and Tarnier, while admitting the correctness of Naegele's conclusions, nevertheless held that the prognosis was always serious, for, even when anterior rotation occurred, the duration of labor was markedly increased and the maternal and foetal mortality augmented.

A comparatively large experience has led me to discount these gloomy views, and to regard the occurrence of posterior presentations with equanimity, provided the pelvis and child are normal in size. Moreover, in view of our uniformly good results, I do not consider it advisable to attempt to convert them into other positions during the course of labor, except when the forceps is to be applied. It is true that labor is somewhat prolonged, and instrumental interference is required more frequently—in 10 per cent. of the cases, according to Varnier, as compared with 3.6 per cent. in anterior presentations. In 281 cases in which delivery occurred spontaneously or was aided by forceps, we had no maternal mortality directly attributable to the posterior position, and only one child was lost.

Even when the occiput rotates into the hollow of the sacrum, the prognosis is not bad, as in the majority of cases spontaneous delivery occurs, being noted by Varnier in 30 out of 35 cases. No doubt in such cases

there is an increased tendency toward perineal tears, which is particularly marked when the head is born by the less frequent mechanism. But to my mind the main cause of the dread in which posterior presentations are held is the fact that they frequently escape recognition, with the result that the large number which rotate anteriorly and end spontaneously are overlooked, and only those cases are recognized in which the occiput remains obliquely posterior. Furthermore, the latter are usually not diagnosed until operative interference becomes necessary, and even then not until repeated failure at forceps extraction leads to careful examination and the recognition that the instrument had been applied improperly—that is, as in occipito-anterior presentations.

When occipito-posterior presentations have descended into the pelvis, it is my practice to leave them to Nature as long as possible, and to interfere only when absolutely necessary. But when convinced that the best interests of the mother and child will be subserved by prompt delivery, forceps should be applied according to the directions which will be given in the appropriate chapter. On the other hand, when the head is arrested at the superior strait in a posterior position, version should be resorted to as soon as one is convinced that spontaneous advance will not occur, provided, of course, that the operation is feasible and is not contraindicated by disproportion between the size of the head and the pelvis.

**Changes in the Shape of the Head.**—In vertex presentations the child's head undergoes im-

portant and characteristic changes in shape, as the result of the pressure to which it is subjected during labor. In prolonged labors in which the



Fig. 269



Fig. 270



Fig. 271

FIGS 269-271.—CAPUT SUCCEDANEUM AT BIRTH; ITS DISAPPEARANCE THREE AND TEN DAYS RESPECTIVELY AFTER LABOR.



membranes have ruptured before complete dilatation of the cervix, the portion of the head immediately over the os is relieved from the general



FIG. 272.—DIAGRAM SHOWING CONFIGURATION OF HEAD IN VERTEX PRESENTATION (American Text-Book).

pressure existing in the uterus, and, as a consequence, a serous exudate occurs under the scalp at this point, giving rise to a soft swelling which is known as the *caput succedaneum*. In most cases this attains a thickness of only a few millimeters, but in prolonged labors, in the circumstances named, it may become very considerable and effectually prevent the examining finger from distinguishing the various sutures and fontanelles. More usually the caput is formed when the head is in the lower portion of the birth canal, and frequently only after

the resistance of a rigid vaginal outlet is encountered. It occurs upon the most dependent portion of the head, and therefore in left occipito-iliac positions is found over the upper and posterior extremity of the right parietal bone, and in right positions over the corresponding area of the left parietal bone. Hence it follows that in many instances after labor we are enabled to diagnose the original presentation by the situation of the caput succedaneum.

More important, however, are the plastic changes which the head undergoes. Owing to the fact that the various bones of the skull are not firmly united, movement may occur at the various sutures. Ordinarily the margins of the occipital bone, and more rarely those of the frontal bone, are pushed under those of the parietal bones; and in many cases one parietal bone may overlap the other, the rule being that the one occupying the posterior position is overlapped by the anterior. These changes are of marked significance, especially in contracted pelvis, when the ability of the child's head to become molded may make the difference between a spontaneous labor and a major obstetrical operation.

As a result of pressure the head also undergoes a marked change in shape, which consists in a diminution of its suboccipito-frontal and occipito-frontal diameters. In other words, it becomes lengthened from chin to occiput and compressed in other directions. This is clearly shown in Fig. 272.

In occipito-posterior presentations, when the occiput has rotated into the hollow of the sacrum, the frontal bone is markedly overlapped by the anterior margins of the parietal bones, which leads to a distinct depression of that part of the head, and gives some idea of the force with which the region of the large fontanelle has been pressed against the lower margin of the symphysis.

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## CHAPTER XIII

### MECHANISM OF LABOR IN FACE, BROW, AND BREECH PRESENTATIONS

**Face Presentations.**—In face presentations the head is markedly extended, so that the occiput is in contact with the back, while the face looks downward. Pinard, in an analysis of 92,026 cases of labor, found 374 such presentations, a percentage of 0.4 per cent.—that is, 1 in every 250 cases.

The face most frequently occupies the right oblique diameter of the pelvis, so that the chin is directed either toward the left ilio-pectineal



FIG. 273.—DIAGRAM SHOWING POSITION OF CHILD IN L. M. A.



FIG. 274.—DIAGRAM SHOWING POSITION OF CHILD IN R. M. A.

eminence or the right sacro-iliac synchondrosis. Accordingly, the left mento-anterior and right mento-posterior are the varieties usually observed.

It is generally stated that face presentations do not exist during pregnancy, but owe their origin to extension of the head at the superior strait at the onset of labor, although Mme. La Chapelle, Naegele, Spiegelberg, Ribemont-Dessaignes, Fieux, and others have described instances in which they were diagnosed during pregnancy. These are designated as primary, in contradistinction to the much more frequent secondary face presentations.

**Diagnosis.**—In the left mento-anterior variety palpation gives the following data:

First manœuvre: Breech in fundus.

Second manœuvre: Back in the right and posterior portion of the abdomen, and distinctly felt only in its upper portion; small parts in left and anterior portion of the abdomen.

PLATE XII.



First manœuvre.



Second manœuvre.



Third manœuvre.



Fourth manœuvre.

PALPATION IN RIGHT MENTO-ANTERIOR PRESENTATION.





Third manœuvre: Marked cephalic prominence on right side.

Fourth manœuvre: Marked cephalic prominence on right side; fingers can be depressed deeply on left.

The reverse holds good in the right posterior variety (Plate XII). The characteristic sign is that the cephalic prominence can be palpated on the same side as the back, the latter being distinctly felt only in the neighborhood of the breech.

On vaginal touch the face is found in the birth canal, and the variety of presentation is diagnosed by the differentiation of the various features, the mouth and nose, malar bones and orbital ridges being the distinctive points. In the left anterior variety the chin occupies the anterior and the brow the posterior extremity of the right oblique diameter of the pelvis, while in right posterior position the reverse obtains.

The heart sounds are transmitted through the thorax; accordingly they are heard through the side of the abdomen which contains the small parts and generally below the umbilicus. The only other condition in which auscultation gives similar results is in brow presentations and in the rare cases of occipito-posterior presentations in which the head is partially extended.

*Causation.*—The causes of face presentations are manifold, and, roughly speaking, are afforded by any factor tending to bring about extension or to prevent flexion of the head. Accordingly we find that they occur more frequently when the pelvis is contracted or the child very large. It is therefore an excellent practical rule to bear this latter possibility in mind whenever one meets with lack of engagement in a normal pelvis. Petitjean believes that the production of face presentation is favored by a low implantation of the placenta, which he has noted in two-thirds of the cases observed in Pinard's clinic.

To Matthews Duncan belongs the credit of having directed attention to the most frequent causative factor—namely, an oblique position of the uterus, which permits the child's back to sag toward the side in which the vertex lies. He pointed out that in such circumstances the attitude of the fœtus becomes distorted and abnormal, so that a slight obstacle to the descent of the posterior portion of the head will result in its extension. This occurs most frequently in right occipito-posterior presentations, as is shown by the fact that, while left occipito-anterior are four times more frequent than right occipito-posterior presentations, the same two varieties of face presentation occur with almost equal frequency. That



FIG. 275.—TUMOR OF NECK CAUSING FACE PRESENTATION.



multiparity would naturally favor the production of this condition is evident, since lax abdominal walls allow the uterus to assume an oblique position.

Thus Pinard and Winckel state that 60 per cent. of their cases occurred in multiparous, and only 40 per cent. in primiparous women.

In exceptional instances, marked enlargement of the neck or thorax, coils of cord about the neck, or spastic contraction of the cervical muscles may cause extension. Again, it is well known that hemicephalic children usually present by the face, as the result of the faulty development of the cranial vault.

Hecker pointed out that face presentations were occasionally due to an elongation of the occipital portion of the head—*dolichocephalus*. There is no doubt that most children that are born by the face have heads of this character, but the fact that they usually resume their normal shape a few days after labor shows beyond question that the deformity is the result, rather than the cause, of the presentation. Zweifel delivered by Cæsarean section a dolichocephalic child, which had presented by the breech before operation, and considered that this



FIG. 276.—DOLICHOCEPHALIC HEAD FROM BREECH PRESENTATION (Jellinghaus).

Hecker pointed out that face presentations were occasionally due to an elongation of the occipital portion of the head—*dolichocephalus*. There is no doubt that most children that are born by the face have heads of this character, but the fact that they usually resume their normal shape a few days after labor shows beyond question that the deformity is the result, rather than the cause, of the presentation. Zweifel delivered by Cæsarean section a dolichocephalic child, which had presented by the breech before operation, and considered that this



FIG. 277.—DIAGRAM SHOWING THAT IN FACE PRESENTATIONS THE OCCIPUT IS THE LONG END OF HEAD LEVER.



FIG. 278.—DIAGRAM ILLUSTRATING IMPOSSIBILITY OF LABOR IN FACE PRESENTATIONS WHEN THE CHIN HAS ROTATED DIRECTLY POSTERIOR.

case demonstrated the possibility of the existence of a primary dolichocephalus; but Fritsch and most observers contend that the peculiar shape

of the head resulted from pressure exerted upon it by the fundus of the uterus. On the other hand, Jellinghaus and Gessner have reported cases



FIG. 279.—DISTENTION OF VULVA IN FACE PRESENTATION (modified from Ahlfeld).

which they believe support the original theory of Hecker; and, on the whole, it would seem probable that such a condition may occasionally bear a causal relation to face presentations.

*Mechanism.*—As face are usually derived from vertex presentations, it



FIG. 280.—DIAGRAM SHOWING DELIVERY OF HEAD IN FACE PRESENTATION.



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is apparent that the former are but rarely observed in a fully developed state at the superior strait, where the brow generally engages, while the face descends only after further extension.



FIG. 281.—DIAGRAM SHOWING DELIVERY OF HEAD IN FACE PRESENTATION.

The mechanism in these cases consists of the *cardinal movements*—descent, internal rotation and flexion; and the *accessory movements*—extension and external rotation. *Descent* is brought about by the same factors as in vertex presentations, while *extension* results from the rela-



FIG. 282.—DIAGRAM SHOWING DELIVERY OF HEAD IN FACE PRESENTATION.

tion which the body of the child bears to its head, the latter being converted as it were into a two-armed lever, the longer arm of which extends from the occipital condyles to the occiput; so that when resistance is encountered the latter is pushed upward, while the chin descends (Fig. 277).

*Internal rotation* has for its object the rotation of the face in such a

manner as to bring the chin under the symphysis pubis, since otherwise natural delivery cannot be accomplished. Only in this way can the neck subtend the posterior surface of the symphysis pubis; whereas, if the chin rotates directly posteriorly, the relatively short neck cannot subtend the anterior surface of the sacrum, which measures 12 centimeters in length, so that the birth of the head is manifestly impossible unless the shoulders can enter the pelvis at the same time, which is out of the question except when the child is very small or premature (Fig. 278).

After anterior rotation the chin and mouth appear at the vulva; the under surface of the chin becomes stemmed against the symphysis, and the head is delivered by a movement of *flexion*, the nose, eyes, brow, bregma, and occiput appearing in succession over the anterior margin of the perineum (Figs. 280, 281 and 282). After the birth of the head the occiput sags backward toward the anus, and in a few moments the chin, by a movement of external rotation, turns to the side toward which it was originally directed, after which the shoulders are born as in vertex presentations.



FIG. 283.—SHOWING DISTORTION OF FACE AFTER DELIVERY IN FACE PRESENTATION.



FIG. 284.—DIAGRAM SHOWING CONFIGURATION OF HEAD IN FACE PRESENTATION (American Text-Book).

In a small number of cases internal rotation, instead of occurring anteriorly, may take place toward the hollow of the sacrum, or, occasionally, as was pointed out by Hodge, the face may engage primarily in this manner. In such circumstances, for the reasons given above, the birth of a normal-sized child is usually impossible. Reed, in 1905, has shown that such a view is somewhat too extreme, for, after reviewing 75 cases of persistent mento-posterior presentations reported in the literature, he found that 17 had been delivered without change of presentation. This, however, should not be taken as

indicating that such positions are not very serious, as in the entire series 11.6 per cent. of the mothers and 40.6 per cent. of the children perished, in spite of attempts at delivery by various methods.

In mental presentations the face becomes distorted owing to the effusion of serum beneath the skin, which when marked completely obliterates the features and is very likely to cause confusion with a breech presentation. At the same time the skull undergoes considerable molding, which is manifested by an increase in length of the mento-occipital diameter and a diminution in the vertical diameters of the head.



*Prognosis.*—Until the latter part of the eighteenth century face presentations were considered extremely unfavorable, and most authorities advised their conversion into some other variety. But about that time Deleurye, in France, and Zeller and Boer, in Austria, pointed out that most of them would end spontaneously if left alone, the latter author stating that he had observed spontaneous labor in 79 out of 80 cases, and had applied forceps in only a single instance.

Owing to the excessive distention of the vulval outlet by the greatest circumference of the head—the mento-occipital—deep tears of the perineum are of frequent occurrence; and owing to the prolongation of labor the foetal mortality is markedly increased, being usually estimated at about 14 per cent., though Weiss lost only 4 out of 78 children (5.1 per cent.).

In dealing with face presentations it should always be borne in mind that internal rotation does not occur until the pelvic floor is well distended

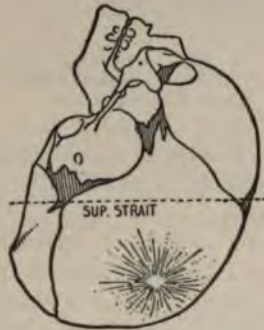


FIG. 285.—DIAGRAM SHOWING THAT WHEN THE VERTEX IS ON THE LINE JOINING THE ISCHIAL SPINES, THE GREATEST DIAMETER OF THE HEAD HAS PASSED THE SUPERIOR STRAIT.



FIG. 286.—DIAGRAM SHOWING THAT WHEN THE FACE IS ON THE LEVEL OF THE ISCHIAL SPINES, THE GREATEST DIAMETER OF THE HEAD IS STILL ABOVE THE SUPERIOR STRAIT.

by the advancing face; and frequently, when the chin is obliquely posterior, it does not take place until the obstetrician has almost abandoned hope of its occurrence. Nor should it be forgotten that the face must occupy a lower level than the vertex before one can feel assured that the greatest circumference of the head has passed through the superior strait. This can be readily appreciated from a study of Figs. 285 and 286, in which it is seen that the distance from the parietal boss to the vertex is only 3 centimeters, whereas a line drawn from the same point to the face will measure 7 centimeters.

*Treatment.*—In the anterior varieties spontaneous delivery is the rule, and, even when the chin is obliquely posterior, anterior rotation usually occurs, although often not until a very late period. In view of the serious prognosis attending its failure, and particularly when the face rotates into the hollow of the sacrum, in appropriate cases an attempt should be made to substitute a vertex presentation. When the face is not deeply engaged

this can be readily accomplished, either by pushing up the chin or by making traction upon the occiput.

When the chin is directed anteriorly, attempts at conversion are not advisable, as they would merely substitute an occipito-posterior position, which is but slightly more favorable than the original face presentation, not to speak of the increased danger of infection attending the manipulation. In obliquely posterior positions, on the other hand, conversion is urgently indicated, and should be attempted as soon as the condition is recognized and the degree of dilatation of the cervix permits. In these circumstances the unfavorable mento-posterior is converted into a favorable occipito-anterior presentation.

From time to time numerous methods have been suggested for this purpose, the oldest and most effectual being the following, advocated by Baudelocque and revived by Thorn, Weiss, and others: Attempts are made to push up the chin by two fingers introduced into the vagina; if this does not succeed the patient is anaesthetized, the whole hand introduced, and the head dislodged, after which the vertex is grasped and drawn down. At the same time the

external hand of the operator or the assistant carries the back in the opposite direction, so as to facilitate flexion. Very excellent results have been obtained by this manœuvre, and its adoption in suitable cases cannot be too strongly recommended.

Schatz suggested the method of external manipulation pictured in most text-books, by which the vertex is substituted for a presenting face. This, however, is rarely available, inasmuch as the presentation does not become well developed until after engagement has occurred.

If the face be too deeply engaged in the pelvis to admit of the Baudelocque manœuvre, the patient should be let alone and descent allowed to take place, in the hope that anterior rotation will occur when the face reaches the pelvic floor. If, however, this does not take place after a reasonable delay, manual rotation should be attempted, and if this cannot be effected forceps should be applied in the manner to be described later, and an attempt made to rotate the chin to an anterior position; finally, if this fails, the only resource lies in pubiotomy or craniotomy.

When the chin is situated directly posteriorly, and the face is only slightly engaged, conversion should be attempted as soon as the condition of the cervix will permit, and, in case of failure, the child should be extracted after podalic version. On the other hand, if the face be so firmly engaged that it cannot be pushed up under anaesthesia, craniotomy or

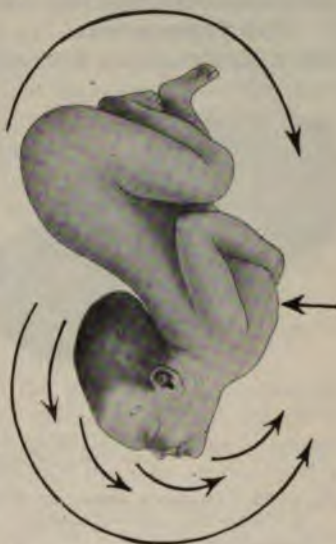


FIG. 287.—DIAGRAM SHOWING DIRECTION OF PRESSURE IN CONVERSION OF A FACE INTO A VERTEX PRESENTATION BY THORN'S MANŒUVRE.



pubiotomy must be resorted to as soon as the patient's condition calls for delivery. The former has been repeatedly practiced, and Morse has collected the few cases in which pubiotomy has been performed, including two successful operations done in my clinic.

**Brow Presentations.**—In brow presentations the head occupies a position midway between flexion and extension; hence the portion situated be-



FIG. 288.—DIAGRAM SHOWING POSITION OF CHILD IN LEFT ANTERIOR BROW PRESENTATION.



FIG. 289.—DIAGRAM SHOWING POSITION OF CHILD IN RIGHT POSTERIOR BROW PRESENTATION.

tween the orbital ridge and large fontanelle presents at the superior strait. As nearly every child which is born by the face has gone through a preliminary stage of brow presentation, the latter must occur quite as frequently as that of the face, later undergoing spontaneous conversion into either a face or a vertex presentation. Persistent brow presentations are extremely rare, and are generally stated to occur once in every 1,500 to 2,000 cases, though von Weiss observed one example in every 1,000 cases.

The causes of this presentation, which have been carefully studied by Ahlfeld, are practically identical with those giving rise to face presentations, and depend upon any factor which interferes with flexion or promotes extension of the head. In twin pregnancies not infrequently one or both children may present in this manner, and Ahlfeld maintains that the anterior surfaces of the two fetuses coming in contact mutually disturb the normal flexed attitude, so that extension is facilitated. Usually the brow is directed toward one or other extremity of the right oblique diameter of the superior strait, and accordingly the left anterior and right posterior varieties are the ones most frequently encountered.

**Diagnosis.**—The presentation can be recognized by palpation and vaginal touch, though the data obtainable from the first are not so characteristic as in the more common presentations. The condition of affairs is found to be very similar to that observed in face presentations, except that the cephalic prominence is less marked on the side of the back, while the resistance offered by the chin can be felt on the same side as the small parts. On vaginal touch the frontal and the anterior portion of the sagittal suture are encountered in one of the oblique diameters, at one end of

which the large fontanelle or the portion of the skull just posterior to it may be felt; while at the other the orbital ridges, the root of the nose, and the eyes may be distinguished. Ordinarily it is not possible to palpate the mouth or chin, for when these are within reach we have to deal with a face presentation.

*Mechanism.*—The mechanism of labor in brow presentations differs materially with the size of the foetus. Ahlfeld and most observers have stated that this is most frequently below the normal; whereas Weiss maintains that large children are the rule. In the former case the course of labor as a rule is quite easy, while in the latter it is usually very difficult. The cause of the difficulty is apparent when we consider that the diameter of the head which must engage at the superior strait is the mento-occipital, which averages 13.5 centimeters in length, and that engagement is therefore impossible, unless the child is of small size, until after marked molding has taken place, by which the mento-occipital diameter has become diminished and the fronto-occipital increased in length.

After molding and descent have occurred the brow usually rotates anteriorly, and the forehead, orbital ridges, and root of the nose appear at the vulva. One of the superior maxillary bones then becomes stemmed against the inferior margin of the symphysis, and the rest of the head is born by a movement of extreme flexion, the brow, bregma, and occiput appearing in succession over the anterior margin of the perineum. After the birth of the occiput, the mouth and chin descend from behind the pubic arch by a movement of extension. In other words, we have a mechanism somewhat similar to that observed in the less frequent mode of delivery in the case of posterior occiput presentations which have rotated into the hollow of the sacrum.

As has already been pointed out, a large child cannot enter the birth canal without considerable molding of the head. This adds materially to the length of labor and results in the birth of children with characteristically deformed heads. The caput is found over the forehead and extends from the orbital ridges to the large fontanelle, and in many cases is so marked as to render diagnosis by vaginal touch almost impossible. In these cases, as is shown in Fig. 290, the forehead is very prominent and square, the mento-occipital diameter being diminished and the fronto-occipital diameter increased in length.



FIG. 290.—DIAGRAM SHOWING CONFIGURATION OF HEAD IN BROW PRESENTATION (American Text-Book).

*Prognosis.*—The outlook in persistent forms of brow presentation is generally considered to be bad, unless the foetus be small. In the transient varieties, of course, it depends upon the presentation which ultimately results, and whether the face or vertex enters the birth canal.

Rational methods of treatment, similar to those indicated in face pres-



entations, and more particularly stricter attention to aseptic technique have led to a marked improvement in the prognosis. Thus Ahlfeld, Fritsch, and Budin (1873-'76) collected 34 cases with 2 maternal and 7 foetal deaths, 4 of which were directly due to the presentation. Weiss, on the other hand, has recently reported 29 cases from Braun's clinic in Vienna, without a death of foetus or mother.

*Treatment.*—If the brow be recognized at the superior strait, the treatment will vary according as the presentation promises to be transient or persistent. The former should be left alone, as it will undergo spontaneous conversion into a vertex or face presentation, and the child will probably be born spontaneously. On the other hand, in persistent cases, particularly if the brow be posterior, attempts at conversion should be made before the head has undergone any great degree of molding—that is, as soon as the first stage of labor is completed. In such cases it is occasionally possible to substitute a vertex presentation by pushing up the presenting part with the fingers in the vagina, while at the same time attempts are made to flex the child's body with the external hand. If these manipulations are not successful, version should be performed, if feasible, as recommended in face presentations. If the brow be deeply engaged, conversion should not be attempted unless one is able to push the presenting part up to the level of the superior strait, when the treatment is identical with that outlined above. But if this cannot be accomplished, version is also out of the question, and the case should be left to nature, and forceps applied when indicated by the condition of the mother or child. It should be remembered, however, that delivery in these circumstances is nearly always associated with considerable injury to the maternal soft parts, owing to the large circumference of the foetal head by which they are distended. Wallich has made an earnest plea for the performance of symphyseotomy in persistent brow presentations, and has reported 7 operations with no maternal and only 2 foetal deaths; while Pinard in 1908 advocated Cæsarean section in appropriate cases.

**Breech Presentations.**—As has already been pointed out, the relation between the lower extremities and buttocks of the child is not always the same in sacro-iliac presentations, and we therefore distinguish between frank breech, complete breech, foot and knee presentations. In all these varieties, however, the mechanism of labor is essentially the same, so that they need not be considered separately.

Usually the breech engages in such a manner that the sacrum is directed to the left side of the mother, and accordingly the left sacro-anterior or posterior are the positions most frequently observed, having been noted in two-thirds of my cases.

In 100,000 cases of labor Pinard observed 3,301 breech presentations—about 3.30 per cent. These statistics include premature as well as full-term labors, but, if the latter alone are considered, we find one in 62 cases.

*Diagnosis.*—On palpation, the first manœuvre reveals a hard, round, readily ballotable body occupying the fundus of the uterus, and when the abdominal walls are very thin one can occasionally obtain a characteristic cracking sensation upon compressing the bones of the skull. By the second

manœuvre the back is found to occupy one side of the abdomen and the small parts the other, position and variety being determined by the location of the former. On the third manœuvre, if engagement has not occurred, the irregular breech is freely movable above the superior strait



FIG. 291.—DIAGRAM SHOWING POSITION OF CHILD IN L. S. A.



FIG. 292.—DIAGRAM SHOWING POSITION OF CHILD IN R. S. A.

while, if it has already occurred, the fourth manœuvre shows that the pelvis is filled by a soft mass which interferes with the penetration of the finger (Plate XIII).

On vaginal examination the diagnosis is made by recognizing the cha



FIG. 293.—FROZEN SECTION, LATTER PART OF PREGNANCY, CHILD IN L. S. T. (Waldeyer)



acteristic portions of the breech. Generally speaking, one can feel both tubera ischii, the sacrum with its spines, and the anus, and when further descent has occurred the external genitalia may be distinguished. In many cases, especially where labor is prolonged, the buttocks become markedly swollen, so that differentiation between the face and breech may be rendered very difficult, as the anus may be mistaken for the mouth, and the ischial tuberosities for the malar bones. Care in examination, however, should prevent this error, for when the finger is introduced into the anus it experiences a muscular resistance, whereas in the mouth the firmer, more unyielding jaws would be felt. Again, on removing the finger, it is not infrequently found to be stained with meconium, which could never occur with a face presentation. The most accurate information, however, is obtained from the sacrum and its spinous processes, for when these are felt the diagnosis of position and variety is established.

In complete breech presentations the feet may be felt alongside of the buttocks, and in footling presentations one or both feet may hang down into the vagina. In the latter case, one can readily determine which foot is encountered by bearing in mind the relation of the great toe. When the breech has descended deeper into the pelvic cavity, the genitalia may be felt, and if these are not deformed by an effusion of serum it is possible to diagnose the sex of the fœtus. Only in such circumstances can we feel certain as to this point before delivery.

The fœtal heart sounds are heard through the back of the child, usually at the level of the umbilicus or slightly above it.

*Ætiology.*—The causes of breech presentations are manifold. According to the experiments of Schatz, the fœtus, when suspended in liquor amnii, always sinks by its buttocks, so that, if gravity were the only factor concerned, breech presentations would be the most frequent of all. As a matter of fact, however, this is by no means the case.

In the later months of pregnancy head presentations result from a process of accommodation between the fœtal ovoid and the uterus; accordingly, breech presentations are prone to occur when the process is interfered with. In the earlier months these factors do not so readily come into play, and breech presentations are accordingly much more common than at term. They also occur very frequently in twin pregnancies and in cases of hydramnios, inasmuch as the increased distention of the uterus interferes with accommodation, when gravity causes the breech to descend. According to Pinard's statistics, 59 per cent. of all breech presentations occur in multiparæ, in whom the flaccidity of the uterine and abdominal walls plays a part in their production. Their occurrence is also favored by the presence of any obstacle which opposes the engagement of the vertex, as in contracted pelves, excessive size of the normal head, or hydrocephalus.

*Mechanism.*—Unless there be some disproportion between the size of the child and the pelvis, *engagement* and *descent* readily occur in one of the oblique diameters of the pelvis, the anterior hip being directed toward one ilio-pectineal eminence, and the posterior hip toward the opposite sacro-iliac synchondrosis. The former usually descends more rapidly than

PLATE XIII.



First manœuvre.



Second manœuvre.



Third manœuvre.



Fourth manœuvre.

PALPATION IN LEFT SACRO-ANTERIOR PRESENTATION.





the latter, and, when it encounters the resistance of the pelvic floor, *internal rotation* usually occurs and brings the anterior hip to the pubic arch, the bitrochanteric diameter of the child coming into relation with the antero-posterior diameter of the pelvic outlet. Rotation usually takes place from the ilio-pectineal eminence to the pubis through an arc of 45 degrees; but occasionally when the back is anterior, and particularly when the posterior extremity is prolapsed, overrotation may occur, during which the



FIG. 294.—DIAGRAM SHOWING DIRECTION OF INTERNAL ROTATION IN R. S. P. POSITION.

posterior hip will rotate past the sacrum and through the opposite half of the pelvis—i. e., through an arc of 225 degrees.

After rotation, descent continues until the perineum is distended by the advancing breech, while the anterior hip appears at the vulva and is stemmed against the pubic arch. By a movement of *lateral flexion* of the body, the posterior hip is then forced over the anterior margin of the perineum, which retracts upward over the child, thus allowing its body to straighten out, when the anterior hip is born. The legs and feet follow the breech and may be born spontaneously, although not infrequently the aid of the obstetrician is required. After the birth of the breech a slight movement of *external rotation* occurs, and the back usually turns somewhat to the front, as the result of the shoulders being brought into relation with one of the oblique diameters of the pelvis. They then descend rapidly and undergo internal rotation, the bisacromial diameter now corresponding with the antero-posterior diameter of the inferior strait. Immediately following the shoulders, the head, which is normally sharply flexed upon the thorax, enters the pelvis in one of the oblique diameters, and then rotates in such a manner as to bring the posterior portion of the neck under the symphysis pubis, after which the head is born in a position of flexion, the chin, mouth, nose, forehead, bregma, and occiput appearing in succession over the perineum (Figs. 295 and 296).

In a small number of cases rotation occurs in such a manner that the



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back of the child is directed toward the vertebral column, instead of toward the abdomen of the mother. In such circumstances the face



FIG. 295.—BIRTH OF HEAD IN BREECH PRESENTATION.

appears under the symphysis pubis, the face, brow, and finally the occiput slipping down under it, as the head is born. It is of the utmost importance to remember that if premature traction be employed the head may become



FIG. 296.—BIRTH OF HEAD IN BREECH PRESENTATION.

extended, when its delivery can only be accomplished by the operation of extraction.

*Prognosis.*—So far as the life of the mother is concerned, the prognosis

differs but slightly in breech and vertex presentations, except that with the former labor is slower and more liable to be complicated by perineal tears, which frequently extend through the sphincter ani muscle. The prognosis for the child, on the other hand, is considerably worse than in vertex presentations, the foetal mortality being generally estimated at about 10 per cent. This figure applies to primiparous women, but a somewhat lower percentage obtains when all classes of cases are taken into consideration. It is not so high in multiparous women, for owing to the greater relaxation of the soft parts the child is more readily expelled spontaneously, and when extraction becomes necessary it is more easily accomplished. Porak states that 1 child in 9 succumbs in the former class of cases, and only 1 in 30 in the latter.

The somber prognosis for the child is due to several factors. In the first place, after the breech is born as far as the umbilicus, the cord is exposed to a greater or lesser degree of compression between the head and the pelvic brim. It is usually stated that not more than eight minutes can elapse between the birth of the umbilicus and the delivery of the head, if the child is to be born alive, while asphyxiation may occasionally occur at an earlier period.

Not infrequently foetal death is due to the premature separation of the placenta, for, if the delivery is not promptly effected after the head has passed into the lower part of the birth canal, the partially emptied uterus may retract to such an extent as to separate the placenta from its walls, and thus put a stop to the utero-placental circulation.

In primiparous women, where considerable resistance is offered by the pelvic soft parts, spontaneous delivery of the head is often unavoidably delayed and foetal death results, unless the child be extracted manually. In all cases of breech presentation, therefore, the obstetrician should be prepared to render prompt assistance if Nature shows herself unable to fulfill her task.

*Treatment.*—In view of the serious foetal prognosis attending breech presentations, the obstetrician should aim to prevent their occurrence as far as possible, and whenever they are diagnosed in the later weeks of pregnancy an attempt should be made to substitute a vertex presentation by means of *external version*. This is readily accomplished in multiparæ with lax abdominal walls, but is much more difficult in primiparæ. After the substitution has been effected, the child should be held in its new position by a properly fitting bandage until engagement of the head occurs, for if this precaution be not taken it is not unusual for the child to revert to its original position. If there is no disproportion between the size of the head and the pelvis, the result is usually excellent, and affords striking proof of the value of routine ante-partum examination. External version may also be attempted in the first stage of labor, provided the breech has not descended deeply into the pelvis; but when it has once become fixed, all such efforts are unavailing, and it is best to leave the case to Nature and be prepared to interfere when necessary.

In most breech presentations spontaneous delivery occurs, and the attitude of the obstetrician should be merely one of expectancy; neverthe-



less, he should always hold himself in readiness to intervene at a moment's notice. For this reason, as soon as the breech appears at the vulva, the patient should be brought to the edge of the bed in order that not a moment may be lost in performing extraction should it become necessary. At the same time everything required for the resuscitation of the asphyxiated child should be ready for instant use. It is most important to remember that the completion of labor is materially facilitated by the arms retaining their normal crossed position over the thorax, as well as by sharp flexion of the head. This is best attained by firm downward pressure upon the fundus as soon as the breech begins to emerge through the vulva, and should be maintained by the nurse or an assistant, so that the obstetrician can keep his hands clean for any emergency.

Owing to the fact that the breech forms a less efficient dilating wedge than the head, care should be taken to prevent premature rupture of the membranes and the escape of the amniotic fluid. For this reason, among others, as few internal examinations as possible should be made. Generally speaking, the frank breech forms a better dilating wedge than the complete breech, inasmuch as it allows a closer application to the margins of the partially dilated os. On the other hand, if interference becomes necessary, the complete breech offers more satisfactory conditions for immediate delivery, as a foot can readily be brought down and used as a tractor, so that the question arises whether it might not be better in the former class of cases to make it a rule to bring down one or both feet prophylactically. Usually this is not advisable, unless some abnormality exists on the part of the mother or child which renders it probable that prompt delivery may be called for. In such cases a foot should be brought down by Pinard's manœuvre as soon as the membranes rupture. The technique of this manipulation, as well as the rules for extraction, will be considered in Chapter XXI.

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## CHAPTER XIV

### PHYSIOLOGY AND MANAGEMENT OF THE THIRD STAGE OF LABOR

**Situation of the Placenta in Utero.**—The older authors believed that the placenta was usually implanted at or in the immediate neighborhood of the fundus. The researches of Schroeder, Pinard, Ahlfeld, Leopold, Holzapfel, and others, however, have shown that this is by no means the rule, but that the most common situation is on the anterior or posterior wall of the uterus, occasionally on its lateral wall, and only in exceptional instances upon the fundus. Fig. 297, which represents a vertical section through the uterus at term, shows the usual mode of attachment. As a rule, the lower margin of the placenta lies somewhat above the internal os, for when it impinges upon or overlaps the latter we have to deal with a pathological condition—*placenta prævia*.

**Mechanism of Separation of the Placenta.**—Under normal conditions the placenta remains fixed to the uterine wall until after the birth of the child, and becomes separated from it only during the third stage of labor. Particularly during the second stage, the uterine contractions bring about a slight decrease in the area of placental attachment, and in its attempt at accommodation the placenta becomes thicker and slightly folded upon itself, its margins being somewhat rounded and prominent. At the same time, however, it is pressed firmly against the uterine wall by the amniotic fluid, through which the intrauterine pressure is transmitted; otherwise it is probable that premature separation would be the rule and not the exception.

After the expulsion of the child, the contraction and retraction of the uterus leads to a marked thickening of its walls, with an almost total obliteration of its cavity, as well as to a corresponding lessening in the area of the placental site. Eventually the disproportion becomes so great that the glandular layer of the decidua is torn through, and the placenta and membranes are peeled off from the walls of the uterus and come to lie free in its cavity, whence they are expelled by further contractions into the collapsed and flabby lower uterine segment or the upper portion of the vagina.

After its extrusion the maternal surface of the placenta still retains a thin covering of decidua, which represents the atrophic compact layer and the innermost portion of the spongy layer of the decidua serotina, which must be stripped off in order to reach the chorionic villi.

**Mode of Extrusion of the Placenta.**—As early as 1789 Baudelocque had described two ways in which the placenta could be extruded from the uterus. Thus, separation from the uterine wall could commence either at

the center of the placenta or at a point in its circumference. "In the first case the middle of the placenta being pushed forward by an effusion of blood beneath it, the organ becomes inverted upon itself in such a manner that it presents by its foetal surface, which is covered by the membranes and vessels . . . But when the placenta becomes detached below, particularly if the loosening begins at a point in the neighborhood of the internal os, the mechanism is



FIG. 297.—DIAGRAM SHOWING RELATION OF PLACENTA TO UTERINE WALL IN LATTER PART OF PREGNANCY.  $\times \frac{1}{2}$ .



FIG. 298.—DIAGRAM SHOWING RELATION OF PLACENTA TO UTERINE WALL IN SECOND STAGE OF LABOR (modified from Schroeder).  $\times \frac{1}{2}$ .

entirely different, for the afterbirth becomes rolled upon itself in the form of a cylinder, whose long axis corresponds to that of the uterus, in such a manner that it presents its detached maternal surface to the examining finger, and its exit is always preceded by a small amount of fluid blood."

These ideas seem to have excited but little interest until 1865, when Schultze advanced the opinion that the placenta was usually expelled by the first method described by Baudelocque. This belief remained practically undisputed until 1871, when Matthews Duncan contended that the second was the more frequent and therefore the normal mechanism. The active discussion aroused by this controversy, although it led to no final settlement



of the question, had the effect of directing more earnest attention to the physiology of this stage of labor.

The two methods are now designated by the names of Schultze and Duncan respectively. In the former separation begins first at the central portion of the placenta, between which and the uterine wall more or less blood is poured out, which gradually increases in amount until a retroplacental hæmatoma of considerable size is formed, which eventually brings about the complete separation of the organ from its site of attachment, while the membranes still remain adherent. The placenta then presents at the internal os by its foetal surface and, passing through the opening in the membranes, drags them after it; it is then expelled from

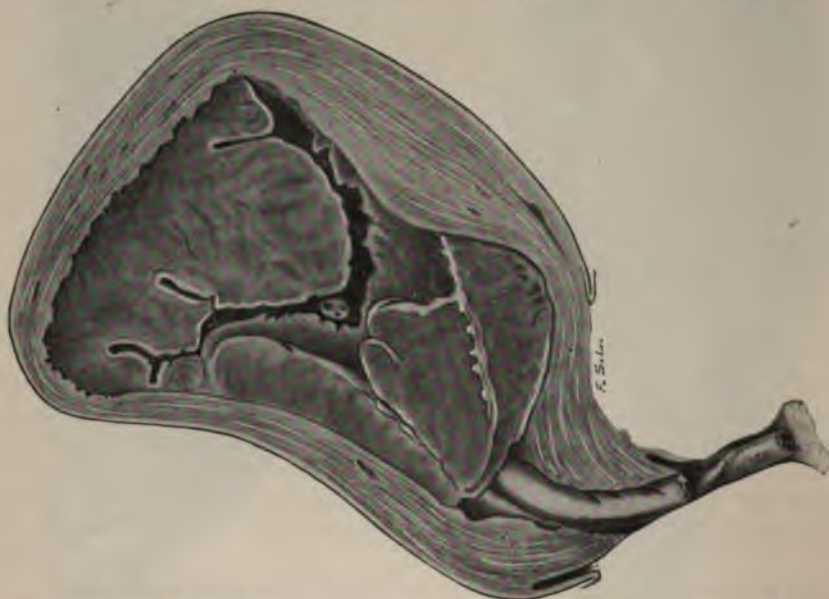


FIG. 299.—FROZEN SECTION, THIRD STAGE OF LABOR, SHOWING THE CONTRACTED UTERINE CAVITY COMPLETELY FILLED BY TWIN PLACENTÆ (Pestalozza).  $\times \frac{1}{2}$ .

the vulva, its foetal or amniotic surface first, and the now inverted membranes following after. In this mechanism there is no escape of blood until after the extrusion of the placenta (Figs. 300 and 301).

In Duncan's method, on the other hand, the placenta, after its separation from the uterine wall, becomes folded upon itself and its lower margin presents at the internal os. It then traverses the vagina and emerges from the vulva by one margin, the membranes being sometimes, but by no means always, inverted. When expulsion occurs in this manner, there is slight but continuous hæmorrhage from the birth of the child until the placenta is delivered (Fig. 302).

With respect to the relative frequency with which these two mechanisms occur there has been much discussion. In this country and in England Duncan's views are commonly accepted, and it is generally held that

Schultze's method borders on the abnormal. In Germany the opinions are still very conflicting, Olshausen and Veit stating that Duncan's method occurs in the majority of cases, whereas Schroeder held that the reverse



FIG. 300.—DIAGRAM ILLUSTRATING EXTRUSION OF PLACENTA BY SCHULTZE'S MECHANISM.

was the case. Moreover, the statistics brought forward by various authors only serve to render the matter still more uncertain. Thus, Ziegler, writ-



FIG. 301.—DIAGRAM ILLUSTRATING LATER STAGE IN THE EXTRUSION OF THE PLACENTA BY SCHULTZE'S MECHANISM.



ing under the inspiration of Fehling, states that he observed Duncan's mechanism in 83.6 per cent. of his cases, whereas in 79.76 per cent. of Ahlfeld's cases that of Schultze was noted.

Holzapfel, in an excellent monograph, has given details and a full literature dealing with the status of the question up to 1899, and, as the result of very interesting experiments and observations, concludes that the pla-



FIG. 302.—DIAGRAM ILLUSTRATING EXTRUSION OF PLACENTA BY DUNCAN'S MECHANISM.

centa nearly always presents at the internal os by Duncan's, but leaves the uterus by Schultze's mechanism.

Although it is difficult to reconcile the contradictory statements of the various observers, it would appear justifiable to class both mechanisms as perfectly normal, that of Duncan occurring most often when the placenta is situated in the lower portion of the uterus, that of Schultze when it is situated in the upper portion.

**Clinical Picture of the Third Stage of Labor.**—Immediately following the birth of the child the remainder of the amniotic fluid escapes, after which there is usually a slight flow of blood. The uterus can now be felt as a firm, hard mass, the fundus lying well below the umbilicus. For a short time the patient experiences no pain, but after a few minutes uterine contractions begin again and recur at regular intervals, until the placenta becomes separated and is expelled into the lower uterine segment.

At some time, varying between five and thirty minutes after the birth of the child, careful palpation shows that the fundus of the uterus has risen up to or above the umbilicus, which is 3 to 7 centimeters above its original position, while simultaneously a slight prominence has appeared immediately above the symphysis pubis (Figs. 303 and 304). At the same time the portion of umbilical cord protruding from the vulva has increased by 10 or 12 centimeters in length. These changes indicate that the placenta

has become detached and has been extruded from the uterine cavity proper into the lower uterine segment, or even into the upper part of the vagina.



FIG. 303.—ABDOMEN IMMEDIATELY AFTER BIRTH OF CHILD.

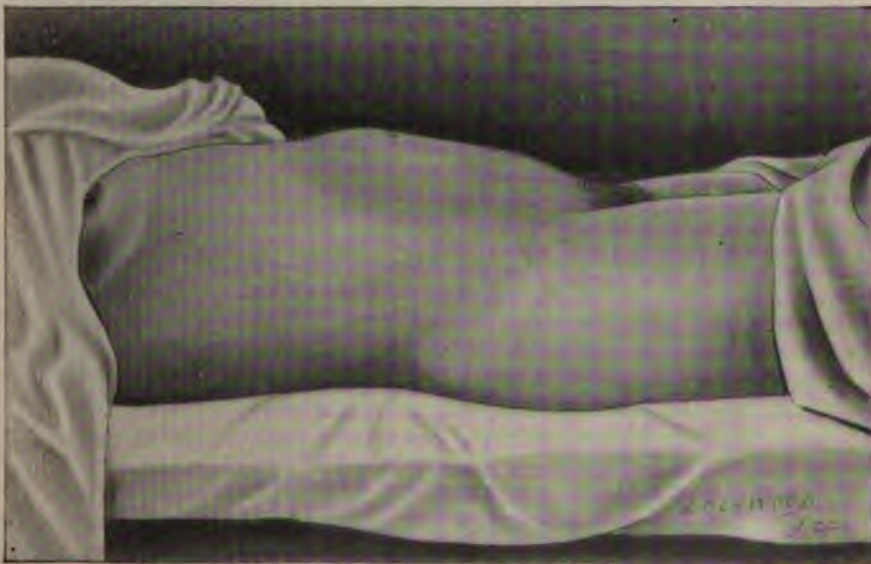


FIG. 304.—ABDOMEN OF SAME PATIENT, SHOWING RISING UP OF FUNDUS FOLLOWING EXTRUSION OF THE PLACENTA INTO THE LOWER UTERINE SEGMENT.

The rising of the fundus is due to the fact that the lower uterine segment, which immediately after the birth of the child had collapsed upon itself,



is now distended by the placenta, and mechanically lifts the empty and tightly contracted uterus to a higher level. In rare cases the placenta is born almost immediately after the child, but as a rule not until fifteen to thirty minutes later, while occasionally hours may pass before it appears at the vulva. The possibility of wide divergence in this respect can readily be appreciated when we remember that the action of the uterus ceases after the placenta has been extruded from its cavity, so that its further descent depends partly upon gravity, but principally upon the contractions of the abdominal muscles. But owing to the great distention to which the latter have been subjected, their tonicity is frequently so impaired that they can no longer exert sufficient force to expel the afterbirth from the vagina, so that in many cases it will not be born for hours unless the patient assumes a sitting position or assistance is rendered by the physician. Ahlfeld has stated that spontaneous termination of the placental period occurred in only 13.6 per cent. of his cases, even when he waited for one and a half to two hours after the birth of the child.

The average loss of blood during the third stage of labor is estimated at about 400 cubic centimeters, a constant but slight flow occurring throughout the entire period when the placenta is delivered by Duncan's mechanism, and a sudden gush of blood immediately following its expulsion by Schultze's mechanism. Ahlfeld found that the average loss was 436 cubic centimeters after normal and 677 after pathological labors. He also holds that the amount lost increases with the size of the child and of the placenta. Moreover, he contends that it is greater the shorter the duration of the placental period, and is least when it lasts for one and a half or two hours, but this is contrary to my experience.

**Management of the Third Stage of Labor.**—Up to 1861 the management of the third stage of labor varied greatly, and delivery of the placenta was effected either by traction upon the cord or by passing the hand into the vagina or uterus, as the case might be, and bringing it away. Both of these methods, but more particularly the latter, as will be explained later, are necessarily attended by grave dangers.

In 1853 Credé described what he considered the ideal method of delivering the placenta, which was somewhat as follows: Immediately after the exit of the child the obstetrician grasps the uterus with his hand and, after waiting from five to ten minutes, gently kneads it, thereby stimulating it to contract and to separate the placenta. The hand is then applied to the abdomen in such a manner that the thumb rests upon the anterior and the fingers upon the posterior surface of the uterus, and as soon as a contraction occurs, firm and steady pressure should be made downward in the axis of the superior strait.

The introduction and routine employment of Credé's method, which aimed at hastening the separation of the placenta and then expressing it from the uterine cavity, undoubtedly marked a most important advance, inasmuch as, by doing away with the necessity for traction upon the cord and the frequent manual removal of the placenta, it has saved the lives of thousands of women. With certain modifications it is now generally employed throughout the world. As a matter of history, Jellett has noted

that the method, while usually ascribed to Credé, had been practiced for many years previously at the Rotunda Hospital in Dublin, and appears to have originated with John Harvie in 1767.

In opposition to the expression of the placenta immediately after the birth of the child, Dohrn, Ahlfeld, and others stated that a greater amount of blood is lost during the third stage, and that there is a greater tendency



FIG. 305.—EXPRESSION OF PLACENTA.

to post-partum hæmorrhage, due to imperfect separation, than when the extrusion of the placenta is left to Nature, or expression is resorted to only after an interval of several hours. But, while it must be recognized as incontrovertible that too early a resort to Credé's method is harmful, inasmuch as it defeats the very purpose for which it is employed and interferes with the physiological separation of the placenta, the arguments adduced in favor of waiting so long a time appear to be neither satisfactory nor rational. It is difficult to see what advantages are to be gained by delaying



expression after the placenta has once become detached from its original site and lies in the lower uterine segment, especially if Ahlfeld's statement is correct that spontaneous delivery will occur only in 13 to 14 per cent. of the cases at the end of two hours. On the other hand, there are certainly very obvious objections to any unnecessary prolongation of the third stage of labor. For the patient such a delay means much additional discomfort and an increased risk of infection; while the busy physician can ill afford the expenditure of valuable time, unless he be convinced that by such personal sacrifice he can better insure the well-being of his patient.

In normal cases, therefore, attempts at expression should not be made until the placenta has been spontaneously expelled into the lower uterine segment or upper portion of the vagina, as is indicated by the rising up of the fundus; but as soon as this has taken place there is no reason why the process should not be hastened. In my own clinic the following procedure has been adopted with most satisfactory results: As soon as the child is born the hand is laid upon the abdomen, and if the uterus be felt as a firm, hard, globular mass it is left alone. On the other hand, if it appears to be soft and flaccid, it is gently kneaded until firm contractions are induced. The condition of the uterus is then carefully watched by applying the hand to it at frequent intervals, but it is kneaded only when necessary. In the majority of cases, after a lapse of ten or fifteen minutes, it is noticed that the fundus rises spontaneously several centimeters above the position which it had just occupied, but at the same time remains firm and hard. This change indicates that the placenta has become separated from the uterine wall and is distending the lower uterine segment or the upper portion of the vagina. In doubtful cases important information may sometimes be obtained by holding the cord lightly between two fingers and making firm pressure upon the uterus with the other hand. If the placenta is still adherent, a distinct wave will be felt in the cord, which will be absent if separation has already occurred. Attention was first directed to the former point by Pinard, Schroeder, and Cohn, but its importance has not been generally recognized. The placenta is now expelled by grasping the uterus and making downward pressure in the axis of the superior strait, using the uterus merely as a piston to shove the placenta downward and outward.

X When the latter appears at the vulva it should be grasped by the hand and the membranes gently twisted into a cord, so as to prevent their being torn off from the margins of the placenta, after which they are slowly extracted.

The modification here recommended, which we designate as "expression from the vagina," leaves the separation of the placenta from the uterine wall absolutely to Nature, and simply expresses it after it has been spontaneously expelled from the uterine cavity, and should not be confounded with the typical Credé method, whose object is to hasten the separation of the organ and to express it from the uterine cavity. In most cases the placenta can be expressed from the vagina within half an hour after the birth of the child; but if the fundus does not rise up spontaneously by the end of that period, it is my practice to attempt to hasten separation by resort to the typical Credé method of expression.

Not infrequently small portions of the membranes may be left behind



*in utero* or in the vagina. If the ends be outside the vulva, they should be seized and the remnants delivered by gentle traction; but otherwise it is advisable to leave them alone and to allow them to be cast off with the lochia, rather than to introduce the fingers into the vagina or uterus in the attempt to remove them.

Immediately following the birth of the placenta the uterus should be palpated again; normally it is found firmly contracted and retracted, and if it remains so there is no danger of hæmorrhage. But, on the other hand, if it shows any tendency toward relaxation, it should be kneaded until it contracts, and the hand kept constantly upon it, so that beginning relaxation may be detected and combated. There is usually no danger of relaxation and consequent hæmorrhage, provided no signs of it appear during the first hour after the extrusion of the placenta. Accordingly, the condition of the uterus should be carefully watched during this period by the physician or nurse. But, even when this duty is delegated to the latter, the physician should remain at the house of the patient for one hour, so as to be on hand in case an emergency should arise.

Occasionally, the amount of blood lost immediately following the birth of the child may be so great as to render imperative the prompt delivery of the placenta, and under such circumstances Credé's method of expression should be employed at once. Under all other conditions, however, we should watch for the rising up of the fundus before resorting to any form of expression.

As soon as the placenta and membranes are born they should be carefully inspected for the purpose of ascertaining whether they have been expelled entire, or whether portions have been left behind in the uterus. If they are perfectly intact, all is well; but if the maternal surface of the placenta shows defects which are not due to mere tears of its substance, but which appear to indicate that a considerable part has been left behind, the hand should be carefully redisinfecting, a sterile rubber glove put on, and the retained portion removed manually, since if allowed to remain in the uterus it nearly always gives rise to hæmorrhage.

In rare cases spontaneous separation does not occur, and it may be found impossible at the end of half an hour to expel the placenta by means of Credé's method. Under such circumstances, unless the condition of the patient be serious, or there be free hæmorrhage, the obstetrician should wait patiently and repeat his attempts at expression at intervals, and should not despair of eventual success until two hours have elapsed. In case of failure, it is probable that abnormal adhesions exist between the placenta and the uterine wall, but, in any case, manual removal of the organ must never be undertaken unless absolutely necessary, as it is a more serious procedure than most obstetrical operations. In the former the hand, which is rarely perfectly sterile, is introduced between the placenta and the uterine wall, and comes in direct contact with the freshly thrombosed vessels at the placental site, which afford a most excellent culture medium for bacteria; whereas in the latter the hands or instruments are introduced into the amniotic cavity, so that whatever micro-organisms may have been carried up by them are likely to be cast off with the afterbirth.



For particulars concerning the control of excessive hæmorrhage or the technique of manual removal of the placenta, the reader is referred to the sections on hæmorrhage and on obstetrical operations, respectively.

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## CHAPTER XV

### CONDUCT OF NORMAL LABOR

The services of the obstetrician should be engaged some time before the expected date of confinement, in order that the patient may be under medical supervision for at least the last few months of pregnancy.

The importance of a careful *preliminary examination*, not later than four to six weeks before term, has already been insisted upon. This can be more conveniently carried out with the patient at home and in bed, when the obstetrician should take careful measurements of the pelvis, determine the presentation and position of the child, and acquaint himself, not only with any abnormality which may exist in the generative tract, but also with the general physical condition. At the time of this visit, it is well to give the patient a list of such articles as may be needed at the time of labor and during the puerperium, and which she is expected to supply. The physician should also communicate with the nurse in order to make sure that she understands the preparations which fall to her share. Experience has taught me that the only way by which mistakes can be avoided is to have all necessary directions written down in black and white, or preferably to use printed cards containing definite and concise instructions for the patient and nurse.

**Preparations for Labor on the Part of the Patient and Nurse.**—At the time of the preliminary examination the physician should inspect the room which is to be used for the confinement and make necessary suggestions as to its arrangement. He should also inquire as to the number of wash-basins which are available; for with the increasing perfection of plumbing the ordinary wash-basin and pitcher are often replaced by permanent wash-stands, so that in the homes of the well-to-do it is sometimes difficult to find a sufficient number for disinfecting the hands and cleansing the patient. Five basins will be needed: four for the use of the physician and one for the nurse; and if so many are not already in the house, a sufficient number, made of plain agate-ware and measuring 10 inches across the top, should be procured.

The patient should also be instructed to provide herself with a bed-pan, a 2-quart fountain syringe for rectal enemata, 15 yards of non-sterilized gauze and 2 pounds each of cotton batting and absorbent cotton for making bed-pads, or 6 prepared sanitary bed-pads and 2 pieces of rubber sheeting, one 1 x 2 yards and the other 1 x 1½ yards. The following articles should be obtained from the druggist at least one month before the expected date of confinement, so that they may be in readiness in case labor should occur unexpectedly:



|                                            |                            |
|--------------------------------------------|----------------------------|
| 100 cubic centimeters Squibb's chloroform, | 1-ounce tube of vaseline,  |
| 4 ounces potassium permanganate,           | 100 bichloride tablets,    |
| 8 " oxalic acid,                           | 8 ounces alcohol,          |
| 4 " boric acid,                            | 4 drams ergotol,           |
| 2-ounce tube of green soap,                | 1 nail-brush,              |
|                                            | 2 pounds absorbent cotton. |

If one has a large obstetrical practice it is advisable to have some reputable druggist arrange and keep in stock a box containing the above-mentioned articles, so that the patient can be told simply to buy an obstetrical outfit.

I give below the card which I have prepared for the nurse, containing directions for the preparations before and at the time of labor, as well as for the care of the mother and baby afterward:

#### DIRECTIONS FOR OBSTETRICAL NURSE

##### PREPARATIONS BEFORE LABOR

(a) See that patient has procured a "Confinement Outfit," and the other articles called for in "Directions for Patients," which include everything you or I shall need except baby clothes.

(b) Prepare a sufficient number of sterile vulval pads.

(c) A week before the expected date of confinement prepare six packages, two containing six towels or diapers each; one containing leggings, two containing gauze sponges, and another containing cotton pledgets. Carefully sterilize and label them.

##### AT TIME OF LABOR

(a) If pains begin between 8 A. M. and 11 P. M., notify me as soon as possible, so that I may know that labor has commenced and make my plans accordingly. But if labor begins between 11 P. M. and 8 P. M., do not notify me until the pains are strong and frequent, or unless you think it necessary for me to see the patient at once.

(b) At the commencement of labor prepare two large pitchers of boiled water. Keep one hot and allow the other to cool, covering each with a clean towel.

(c) When labor has definitely set in, give the patient a warm bath and a soap-suds enema.

(d) Make up the bed on the *left* side.

(e) Procure a piece of oilcloth or an old rug to protect the floor.

(f) Don't give vaginal douches of any kind.

(g) Don't examine patient vaginally under any circumstances.

(h) To prepare the patient for vaginal examination place her upon a douche pan, and cut the pubic hairs, if necessary. Then wash the genitalia thoroughly from above downward (toward the anus) with soap and warm water, using cotton pledgets instead of a wash cloth. Finally, bathe the

vulva with a 1-1,000 bichloride solution, and then cover it with a towel soaked in the same solution.

(i) Before a vaginal examination, or when the birth of the child appears imminent, roll the nightgown up above the patient's hips and pin it in position, then put on the obstetrical leggings.

#### AFTER LABOR

(a) As soon as labor is over, cleanse the genitalia with cotton pledgets and water, and then bathe with bichloride solution, after which apply a sterile vulval pad and place the patient upon a sterilized bed-pad.

(b) Don't use an abdominal binder until after the tenth day, unless otherwise directed.

(c) Change vulval pad as often as necessary, washing the genitalia each time with a 1-4,000 bichloride solution.

(d) Take temperature and pulse four times a day (8, 12, 4, and 8), unless otherwise directed, and record upon chart.

(e) Don't catheterize unless the bladder is distended, and not until after the patient has failed to urinate in a sitting position.

(f) Give  $\frac{1}{2}$  oz. of Rochelle salts the morning after labor, and repeat in four hours if not effectual.

(g) Bathe nipples with saturated boracic solution before and after each nursing.

(h) Watch carefully for cracked nipples, and report them to me at once.

(i) Diet: First twenty-four hours, milk, soup, coffee or cocoa and buttered or soft toast. Second and third days, as above, with the addition of boiled or poached eggs, raw or stewed oysters, chicken breast, and wine jelly. Fourth and fifth days, as above, with the addition of sweetbreads, steak, chops, potatoes, rice, and fruit. Then gradually return to ordinary plain diet.

#### CARE OF CHILD

(a) Leave the baby alone until the mother is cared for, wrapping it in a woolen cloth and putting it in a safe place. (Not upon the mother's bed or upon chairs.)

(b) Wash the eyes with a boracic acid solution, unless otherwise directed.

(c) Rub the child thoroughly with vaseline or sweet oil, and then bathe it with castile soap and warm water.

(d) Dress the cord with boracic acid powder and sterile cotton, or an alcohol dressing.

(e) Wash the child daily in your lap, but do not give a full bath until the cord comes off.

(f) Feeding: Until the milk appears, nurse three times a day, and don't give any other food unless directed. After the milk appears, let the child suckle, except after its bath, *every three hours by the clock*, from 6 or 7 A. M. to 10 or 11 P. M. Time one feeding so that it will come directly



after the bath, after which the child may be allowed to sleep as long as it will.

Feed only *once* between bedtime and 6 or 7 A. M.

As soon as the milk appears, write out a schedule for nursing and adhere to it, awakening the child at each feeding time if necessary.

Before each nursing wash out the child's mouth with boracic acid solution.

After the first three weeks give one bottle of milk a day, no matter how much milk the mother may have.

(g) Weigh the child twice a week and record the weight.

**Preparations on the Part of the Physician.**—When the physician has promised to attend an obstetrical patient he should hold himself in readiness to respond promptly at any hour within two weeks of the expected date of confinement, and should instruct the patient as to the best method of communicating with him without delay. If he is obliged to leave town about that time, he should notify the patient and arrange for a competent substitute to take his place if necessary. He should also remember that the proper care of such cases requires a great deal of time, and frequently no small sacrifice of personal convenience, and if he is not willing to place himself at the disposal of his patients, as far as may be necessary, he should refuse to attend them. Undue haste is one of the most frequent causes of unsatisfactory results in this branch of medicine.

The physician should provide himself with an *obstetrical kit*, which should be neatly packed in an appropriate box or valise and be kept ready for immediate use. It should contain not only the instruments which he may need, but also the various drugs required for hand disinfection, anæsthesia, and the usual emergencies, as well as a certain number of sterile towels and dressings, in case the patient has failed to provide herself with such materials, and for sudden calls or consultations. The obstetrical valise should contain a pelvimeter, a pair of nail-clippers and a nail-cleaner, chloroform, permanganate of potash, oxalic acid, bichloride tablets, green soap, sterilized vaseline, and a nail-brush, ergotole or fluid extract of ergot, tablets of sodium chloride for preparing normal salt solution, and a hypodermic syringe with the usual tablets. There should also be a chloroform inhaler, a suit of white clothes, two packages containing 6 sterile towels each and one each of sterilized absorbent cotton and of gauze sponges, as well as several sterilized roller bandages for packing the uterus. Glass tubes containing sterile catheters, catgut and silkworm-gut sutures, and bobbin for tying the cord are also needed, as well as a legholder, and a Kelly perineal pad for operative cases.

The following instruments for repairing perineal and cervical lacerations should be ready for instant use in a sterilized package: A pair of scissors, a needle-holder, 4 artery clamps, dissecting forceps, long dressing forceps, bullet forceps, a three-bladed or a Simon speculum, and an assortment of needles. The valise should also contain a tin box, 40 x 13 x 10 centimeters, provided with a lid and wooden handles. In this the various instruments can be packed when not in use, and at operations it serves as a boiler and as a receptacle for them after sterilization. A Tarnier

axis-traction, or an ordinary Simpson forceps, should be carried, according as the physician has become accustomed to the one or other instrument, as well as a 3-quart fountain syringe with a glass nozzle for intrauterine, and a hollow needle for subcutaneous injections of salt solution. The latter

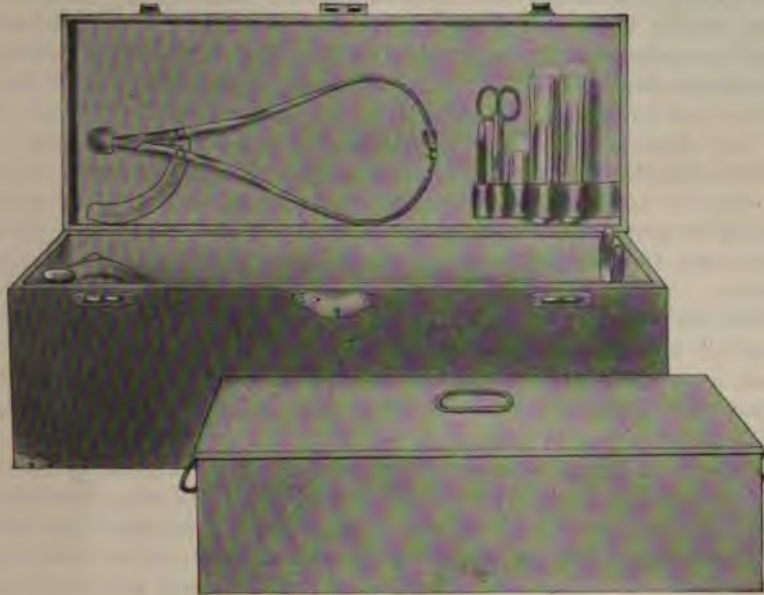


FIG. 306.—OBSTETRICAL BAG.

should be sterilized in advance and wrapped in a sterile towel, so as to be ready for immediate use.

This list does not include the instruments required for the destructive operations, as they are not usually carried by the general practitioner. Everything mentioned in the above list may be packed into a box 21 x 8½ x 8 inches.

**Conduct of the First Stage of Labor.**—As soon as the nature and severity of the pains indicate that labor has set in, the patient should receive a full bath and a rectal enema. When the physician arrives he should make a careful external examination, map out the presentation and position of the child, and listen to the foetal heart. If the pelvis be normal, and the vertex firmly engaged, there is no necessity for making a vaginal examination, provided that the heart sounds are in good condition. Information concerning the degree of dilatation of the cervix can be obtained by rectal examination, although one can usually form a fairly accurate idea from the behavior of the patient and the extent to which the head has descended into the pelvis, as shown by external palpation. Again, the rupture of the membranes and the onset of bearing-down pains usually indicate the beginning of the second stage. If examination shows that labor is not well advanced, there is no necessity for the physician to remain with the patient, and he may leave to return again in a few hours. He



should not, however, leave the house if the external os is fully dilated in a primiparous woman, or half dilated in a multipara, as in the latter the first stage is frequently very short, and the second occasionally terminates with a few expulsive pains.

In general, if no abnormality is suspected, and the physician is well trained in the technique of abdominal palpation and rectal examination, vaginal examinations are unnecessary unless labor is unduly prolonged. They should be avoided for two reasons: to minimize the possibility of infection and to save the feelings of the patient as far as possible.

*Hand Disinfection.*—It is now generally admitted by all competent authorities that it is impossible, in a large proportion of cases, at any rate, to render the hands absolutely sterile, no matter what method of disinfection may be employed. Even after the most rigorous directions have been scrupulously followed, there still remains a not inconsiderable danger of infection.

With the view of still further minimizing these risks, the use of rubber gloves has been introduced. These can be rendered perfectly sterile by boiling, and, when drawn over the carefully disinfected hands, afford the greatest safety possible. Since, however, they are liable to tear occasionally, the necessity for disinfecting the hands before putting them on is apparent. But their employment, even in conjunction with all our other precautions, does not entirely do away with the possibility of introducing bacteria into the genital tract, since I have shown that pathogenic organisms are present upon the inner surfaces of the labia and the margins of the hymen in at least 60 per cent. of pregnant women, and that the mere introduction of a sterile glass speculum 2 centimeters in diameter, which is no larger than the two fingers employed for examination, carries micro-organisms into the vagina in at least one-half of such cases. Moreover, inasmuch as the delicate structure of the parts renders their thorough disinfection out of the question, and as the examining fingers necessarily come in contact with them, it must be admitted that vaginal examinations during labor can never be entirely devoid of danger, and they should therefore be avoided so far as is consistent with the welfare of the patient. While these considerations should not deter us from making as many examinations as may be necessary in abnormal cases, it should always be borne in mind that the best results are obtained by the least possible employment of the vaginal touch, and the widest possible utilization of other methods of examination.

If the hands of the physician have recently come in contact with infectious material at operation or autopsy, labor should be conducted by external manipulations alone, vaginal examinations being made only in the presence of some abnormality, and then only by the gloved hand after most careful disinfection.

In all cases the hands should be disinfected as carefully as for a major surgical operation. The best method for this purpose, introduced by Dr. Halsted some years ago, and described by Dr. Kelly in 1891, consists of the following steps:

1. Cut the finger-nails with clippers or scissors to 1 millimeter in length.

2. Scrub the hands and forearms up to the elbows vigorously with nail-brush, green soap, and hot water, for five minutes or longer by the clock until they are macroscopically clean, paying particular attention to the nails and palmar surface of the fingers. The water must be changed at least once. After changing it, remove dirt from beneath the finger-nails with nail-cleaner or knife and renew the washing.

3. Rinse the hands in fresh water and then soak them in a hot saturated solution of potassium permanganate until they take on a deep mahogany-brown color.

4. Dissolve this off in a hot saturated solution of oxalic acid.

5. Then soak the hands and forearms in a 1-1,000 bichloride solution for at least three minutes by the clock.

6. Draw on the rubber gloves, which have previously been sterilized by boiling, and use no lubricant unless the entire hand is to be introduced into the vagina.

The only objection which can be made to this method of hand disinfection is the length of time which it requires and the roughness of the hands which sometimes follows it. The first objection cannot be overcome, as I do not believe that the hands can be thoroughly disinfected in less than ten minutes by any method. The second can be obviated to a great extent by anointing the hands with glycerin or some emollient after the examination has been made.

The rapid method of disinfection introduced by Fürbringer, by which he believed that the hands could be rendered absolutely sterile in three minutes, has been shown by later experimental work to be absolutely unreliable. Nor have the recent methods of disinfection by means of alcohol substantiated the claims which have been made for them, inasmuch as Krönig has shown that they are based upon a fallacy, and that alcohol does not possess a markedly germicidal action, but simply produces conditions in the skin which for the time being render it difficult to remove the organisms from its surface.

For a number of years I have worn rubber gloves of medium thickness in the conduct of all cases of labor, and cannot endorse their employment too strongly. Provided they have been properly boiled and drawn over the carefully disinfected hands with a suitable technique, they afford the patient absolute protection against infection by the physician's hands; but, as has already been indicated, they offer no guarantee against infection by bacteria which may be carried up from the external genitalia. The objection that their use interferes with the sense of touch is not valid, as I know from my own experience that it can be overcome by practice, so that the most delicate procedures may be conducted just as satisfactorily as with the bare hand, with the one exception of rupturing the membranes. Consequently I urgently advise any one expecting to practice obstetrics to become accustomed to their use at the beginning of his career.

An almost equally important prophylactic measure against infection consists in the greatest possible utilization of rectal examination. In nine cases out of ten it enables one to ascertain with the greatest accuracy the degree of dilatation of the cervix and the position of the presenting part



in the pelvis. Furthermore, it has the additional advantage of not requiring disinfection on the part of the physician or the patient, as the non-sterilized glove is drawn directly over the unwashed hand, and the index finger introduced into the rectum, the glove being boiled and the hand washed after completion of the examination.

*Preparation of Patient for Examination.*—While the physician is disinfecting his hands, the nurse should be making her preparations for the internal examination. The patient should lie on the right or left side of the bed, according as the physician prefers to examine with his right or left hand. She should then be covered with a sheet, which is pulled up from the foot of the bed and its ends wrapped about the legs in such a manner as to leave the external genitalia free with the least possible exposure of the rest of the person. The bedclothes should not be thrown back so as to leave the legs of the patient exposed. Nor should the physician be expected to examine under any covering. After placing her upon a douche pan, the vulva and the inner surfaces of the thighs are thoroughly washed with soap and hot water, particular attention being paid to the



FIG. 307.—SHOWING PROPER METHOD OF COVERING PATIENT WITH SHEET BEFORE MAKING A VAGINAL EXAMINATION.

regions about the anus and clitoris. If the pubic hairs are very long they should be cut short with scissors or shaved. After a thorough cleansing the parts should be rinsed with fresh water and then sponged with a 1-1,000 bichloride solution, after which they should be covered with a towel soaked in the same solution, which remains in place until the physician is ready to commence his examination. Finally, a sterile towel should be placed under the patient's buttocks, so as to prevent the examining hand from coming in contact with the bed.

*Method of Making a Vaginal Examination.*—After thorough disinfection, the thumb and forefinger of one hand distend the labia widely, so as to expose the vaginal opening and prevent the examining fingers from coming in contact with the inner surfaces of the labia and the margins of



FIG. 308.—ILLUSTRATING SPREADING APART THE LABIA BEFORE MAKING A VAGINAL EXAMINATION.

the hymen, while the index and second fingers of the other hand are anointed with sterile vaseline and introduced into the vagina.

In making the examination a definite routine should be followed: 1. The fingers should be introduced along the anterior surface of the vaginal wall, and the shape and size of the pubic arch and the height of the symphysis noted. 2. The cervix should then be examined in order to determine whether its canal is obliterated, the degree to which the external os is dilated, and the character of its margins. Next we observe whether the membranes are intact or not, great care being taken to avoid rupturing them if the patient is in the first stage of labor. 3. If the os be dilated, the presentation and position of the child should be made out, and the relation of the presenting part to the superior strait and to the line connecting the ischial spines determined. 4. After having decided these points the palmar surface of the fingers should be directed posteriorly, and the perineum palpated between the two fingers in the vagina and the thumb outside, with special reference to its consistency, thickness, and resistance. 5. The mobility of the coccyx should then be tested, after which the fingers should be passed upward over the anterior surface of the sacrum and its vertical and lateral curvature noted. If the presenting part is not low down, the three lower sacral vertebræ are readily palpable in normal



women, whereas the first and second can be felt only in contracted pelves. 6. If the presenting part is not deeply engaged, the diagonal conjugate should be measured.

After completing the examination, the physician is usually expected to express an opinion as to the probable course of events. If everything is normal, he should assure the patient that all will be well, but he should guard against making any very definite statement as to the probable duration of labor, and be content with saying that under such circumstances the average time is only a certain number of hours, and that her suffering will probably be ended within that period. The obstetrician who ventures to make more precise statements will speedily find that his predictions are often very faulty, even when the head is on the perineum. If some abnormality be present it is not always wise to inform the patient of the fact, but the physician should be careful to impart his knowledge to some responsible member of the family for his own protection, in case an emergency should arise.

During the first stage of labor the patient usually prefers to move about her room, and frequently is more comfortable when occupying a sitting position. During this period, therefore, she should not be compelled to take to her bed unless she feels so inclined, and when she does so she should be cautioned against attempting to hasten labor by voluntarily bringing her abdominal muscles into play, for they have little or no effect upon the dilatation of the cervix, and the effort will only serve to exhaust her strength.

**Conduct of the Second Stage of Labor.**—The beginning of the second stage of labor is usually indicated by the rupture of the membranes and the onset of bearing-down pains, though these signs are not absolutely characteristic, as rupture may occasionally occur at an early period, or the patient may attempt to hasten the course of labor by making premature use of her abdominal muscles. On the other hand, the membranes sometimes remain intact until they protrude from the vulva. In still rarer cases they do not rupture at all, the child coming into the world surrounded by them, or, as it is popularly termed, being born with a *caul*.

In the latter part of the first stage the pains generally become so severe that the patient instinctively seeks the recumbent position; but if she is still moving about the room or sitting up, she should go to bed immediately upon the rupture of the membranes and the beginning of bearing-down pains.

**Preparation of the Bed.**—The bed should be prepared as soon as the pains become severe, since in the case of a multiparous woman the second stage of labor is often extremely short, and delivery occasionally occurs while the patient is being moved from a chair or sofa to the bed. A high single iron bedstead is preferable, but in private practice one usually has to be content with the ordinary double bed. Under such circumstances one side of it should be prepared for the patient; whether the right or left depends upon which hand the physician expects to use for vaginal examination and the conduct of labor. A large piece of rubber sheeting, 1 x 2 yards, should be placed over the center of the mattress, covering its entire



width, and over this a sheet is spread. A second piece of rubber sheeting,  $1 \times 1\frac{1}{2}$  yards, is placed upon the side of the bed upon which the patient is to lie, in such a position that it will come directly under her buttocks. The entire bed is then covered by a draw-sheet; over this is placed a sterile bed-pad, upon which the buttocks rest. With this arrangement, the upper sheet and the smaller piece of rubber cloth can be removed at the completion of labor, leaving the mattress protected by the large piece of rubber sheeting and the under sheet. In ordinary deliveries I have abandoned the use of the rubber obstetrical pad, and have replaced it by sterile, absorbable bed-pads; as the former is very difficult to keep clean, and owing to the irregularities of the surface of the bed frequently defeats the purpose for which it was devised, in that the fluid which collects in it escapes over the bed and under the patient. To avoid exposure, the legs should be encased in long leggings, which reach to the thighs and are pinned to the rolled-up nightgown. In winter these may be made of canton flannel and in summer of thin muslin.

*Examination of the Patient.*—After the patient has been put to bed, the question arises whether or not a vaginal examination should be made, and this is determined by the condition of affairs in each case. If the head has become engaged in the first stage of labor, it can be omitted; but if the presenting part is not engaged, or any abnormality is present or suspected, an internal examination is absolutely necessary in order to ascertain whether the cord has prolapsed, or if everything is as it should be.

If the patient has apparently been in the second stage of labor for some time without rupture of the membranes, an examination is advisable in order to determine the condition of the cervix; for, after it has become completely dilated, the membranes have served their purpose and retard, rather than hasten, the birth of the child, so that it may be advisable to rupture them artificially. Formerly this was usually readily accomplished by sawing through them with the finger-nail, or by pinching them between the two examining fingers, but this cannot be done when rubber gloves are worn, so that it becomes necessary to resort to instrumental means. For this purpose a sterilized bullet forceps is admirably suited, but if it is not available, a large safety pin, previously sterilized by boiling, is a convenient substitute. The membranes should not be ruptured during the acme of a pain, particularly when the head is not deeply engaged, as occasionally the rush of amniotic fluid may be so great as to carry the cord along with it, and thus bring about its prolapse. The beginner should always be careful to differentiate between the distended membranes and a tense caput succedaneum.

When vaginal examinations are made in the second stage of labor, the same stringent precautions as to disinfection of the hands and the patient's genitalia should be observed. When the head is deeply engaged in the pelvis, such examinations are quite unnecessary, as its descent can readily be traced by the increasing difficulty with which the cephalic prominence is felt on employment of the fourth manœuvre. Moreover, when it can no longer be felt from above, if the legs are widely separated and the tips of the fingers applied to the perineum, to the side of and in front



of the anus, and pressed firmly inward and upward, the presenting part can be felt as a firm, rounded body. Generally speaking, this manoeuvre becomes available as soon as the head has passed below the level of the ischial spines.

During the entire second stage auscultation should be practiced at frequent intervals, particularly when the head has reached the pelvic floor, for occasionally the cord is pressed upon tightly, and the child may become asphyxiated at this period and be lost, if not delivered promptly.

*Delivery.*—As soon as the head can be palpated through the perineum preparations should be made for delivery. A table should be placed in

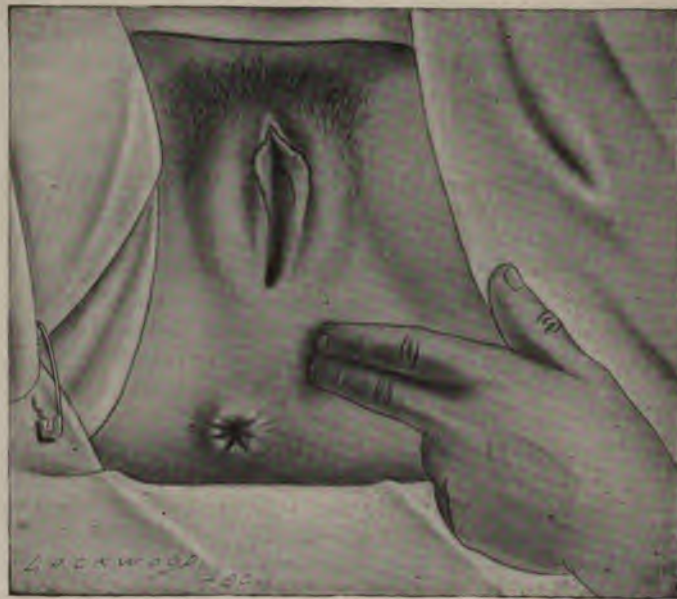


FIG. 309.—PALPATING HEAD THROUGH PERINEUM.

a convenient position at the side of the bed, and upon it a basin of boiled water and another of 1-1,000 bichloride solution, as well as sterilized cotton pledgets or gauze sponges, a certain number of sterile towels, and the material for tying the cord. The instruments needed for the repair of the perineum should also be within easy reach.

The patient should then be placed in position upon the bed. In this country it is customary for her to lie upon her back with the legs drawn up, though in England and many places on the Continent the lateral position is preferred. I prefer the former, as it affords better facilities for the preservation of an aseptic technique. If the leggings have not been used, they should now be drawn up and pinned to the nightgown, which has been rolled up beneath the patient's back, so that it may not be soiled. The genitalia should again be washed with soap and water, and bathed with a bichloride solution.

After having drawn freshly boiled gloves over his carefully disinfected hands, so that he may make an immediate vaginal examination if necessary, the physician should place a sterile towel beneath the patient's buttocks, a second over her abdomen, and others over her legs, and pin them

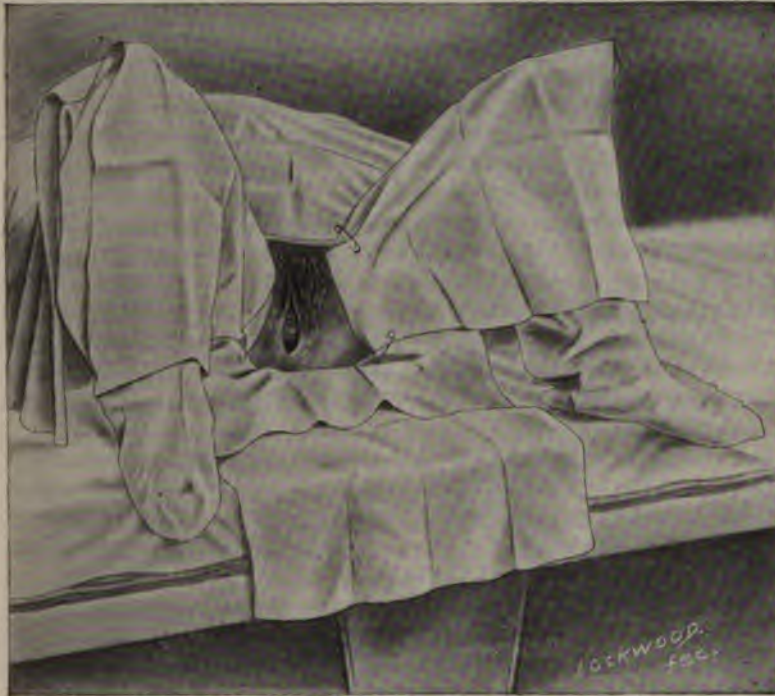


FIG. 310.—SHOWING PATIENT IN PROPER POSITION FOR DELIVERY, AND COVERED BY STERILE DRESSINGS.

in place so as to cover everything in the neighborhood of the genitalia with which his hands may come in contact, leaving only the vulva and perineum exposed.

As the head passes down into the pelvis small particles of feces are frequently expelled, and as they appear at the anus they should be wiped away with a piece of cotton, after which the parts should be sponged off with fresh pledgets soaked in bichloride solution.

As soon as the head begins to distend the vulva, the patient's sufferings become greatly increased, and are frequently excruciating. At this stage it is advisable to begin to use chloroform, partly to relieve the pain, and partly to aid in protecting the perineum. If the nurse be competent, its administration should be intrusted to her. The patient having been instructed to give notice as soon as she feels a pain beginning, several drops of chloroform are poured upon an Esmarch inhaler, and she is told to inspire deeply. This is repeated with each pain, the inhaler being removed immediately after its cessation. In this manner, after a short time, the sensation of pain becomes markedly diminished, while the patient retains



consciousness and is generally able to talk rationally. But, when the head begins to emerge from the vulva, the chloroform should be pushed to complete anæsthesia, during which the head is born. This degree, however, should last only for a few moments.

*Protection of the Perineum.*—As soon as the perineum shows signs of bulging the physician should make preparations for its protection, placing himself in such a position as to be able effectually to check the progress of the head if necessary.

Injuries to the perineum are of very frequent occurrence, and cannot always be avoided even under the most skillful treatment. The statements as to their frequency vary considerably, but all authorities agree that they occur much oftener in primiparous than in multiparous women. Thus, Schroeder observed them in 34.5 and 9 per cent. of his cases respectively; Balandin in 25.99 and 4.19 per cent., and Olshausen in 21.1 and 4.7 per cent. These figures would seem to be rather too conservative, as slight tears implicating the fourchette occur in about two-thirds of all primiparæ, and in 10 per cent. of multiparæ. Occasionally one meets with physicians who state that they have delivered several thousand women with one or two, or possibly without a single, perineal tear. Such statements, however, are always erroneous, and merely indicate that the physician has not inspected the parts after labor, and designates as torn only those cases in which the vagina and rectum have been converted into a cloaca, to the existence of which his attention would assuredly be called by the patient.

In the greatest number of cases the fourchette alone suffers, but not uncommonly the tear extends through a greater or lesser portion of the perineal body and is usually associated with another extending some distance up one or both vaginal sulci, while in rare cases the entire perineum is torn through and the rectum opened up. The first two varieties are frequently unavoidable, but the common occurrence of complete tears is an indication of negligence.

Generally speaking, the causes of rupture are fourfold: disproportion between the head and the vulva, too rapid expulsion, abnormalities in the mechanism of labor, or a narrow pubic arch. Where the head is excessively large or the vulva excessively small, the mechanical conditions are such that birth cannot take place without a certain amount of laceration. In not a few cases the tearing is due not so much to absolute disproportion between the head and the vulva as to the lack of elasticity of the perineum, which is particularly marked in elderly primiparæ. Too rapid expulsion, however, is a much more frequent cause of rupture, and when the head is suddenly and forcibly extruded through the imperfectly distended vulva its mode of production is manifest.

Various abnormalities in the mechanism of labor favor rupture of the perineum. The most frequent of these is imperfect extension of the head, so that the vulva is distended by the occipito-frontal, instead of the suboccipito-bregmatic or suboccipito-frontal circumference. In a certain number of cases the presenting part may be directed too far backward—in other words, extension does not occur—and under the influence of the uterine contractions the presenting part is forced directly downward



upon the perineal body, instead of being guided upward and forward toward the vulval opening. Frequently a similar condition is observed in women having funnel-shaped pelves, in which the pubic arch is long and narrow, whereby the head is prevented from engaging directly under the symphysis pubis. Again, in rare instances, an abnormal inclination of the pelvis, by causing the vulval opening to look more upward than usual, may bring about a similar condition. In considering the mechanism of labor, we directed attention to the factors which predispose to perineal rupture, when the head is delivered in persistent occipito-posterior positions, or when the child presents by the brow, face, or breech.

Giffard, in 1733, was the first to direct attention to the advisability of attempting to prevent perineal tears, and very precise directions were given by John Harvie in 1767. Numerous devices have since been suggested having the same object in view, but their very multiplicity argues that they are not uniformly satisfactory. In most of the older methods pressure was applied directly to the perineum, or various attempts were made to relieve the tension to which it was subjected, so that the physician was said to support the perineum. An excellent *résumé* of the early literature upon the subject will be found in Goodell's scholarly article, published in 1871.

In the method which has stood me in best stead, no attempt is made to support the perineum by pressure, but the obstetrician simply endeavors to favor extension of the head and prevent it from being suddenly extruded during the acme of a pain. For this purpose, when the vertex distends the vulva widely, it should be seized between the thumb and three fingers of one hand, and forcible pressure made against it during each pain, in such a manner as to bring the occiput, and later the nape of the neck, directly in contact with the inferior margin of the symphysis, and thus increase extension. Accordingly, as soon as the head appears at the vulva, the physician should be ready to restrain its progress. He should hold his hand in such a manner as to be able to bring it immediately into action, for in many instances the resistance of the vulva is unexpectedly overcome, and a single pain may be sufficient to push the head suddenly through it with a resulting perineal tear. After the head is so far born that the vulva is distended by the parietal bosses, it may be advisable to attempt to express it by *Ritgen's method* in an interval between the pains. For this purpose, the patient having been instructed to open her mouth and not to attempt to bear down, the anæsthesia is deepened. At the same time two fingers are applied just behind the anus, and forward and upward pressure is made upon the brow through the perineum.

The student is warned from attempting to protect the perineum by any method which aims at stripping it back over the presenting part. Such a procedure is useless, even if carried out successfully, and not infrequently, while it is being attempted, the head will suddenly shoot past the hand and cause a more or less severe laceration. The same may be said of the introduction of the finger into the anus, for the purpose of drawing the perineum up over the head, as suggested by Dr. Goodell. In fact, all such procedures are not only of questionable utility, so far as



the protection of the perineum is concerned, but are dangerous in that they contaminate the hand and throw it out of function in case an emergency should arise which calls for its prompt introduction into the genital tract.

Many obstetricians introduce one or two fingers into the vagina as soon



FIG. 311.—METHOD OF HOLDING BACK HEAD TO PROTECT PERINEUM.

as the head reaches the pelvic floor, so that it may not surprise them by a sudden advance. Such a practice is extremely reprehensible, as it markedly increases the possibility of contamination and infection.

Many authorities, when rupture of the perineum seems imminent, advise the performance of *episiotomy*. In this operation a strong pair of scissors is introduced between the head and the perineum, and an oblique incision made downward and backward on either side between the anus and the tuber ischii. The operation is practiced in the belief that the vulval opening, if sufficiently enlarged by the incision, will not tear farther, or that in any case the laceration will occur in the continuation of the incisions, whose clean-cut edges will heal more readily than the irregular spontaneous tears. Personally, I see no advantage in the procedure, as my experience is that ordinary perineal tears will heal almost uniformly if properly sutured and cared for.

*Coils of Cord about the Neck.*—Immediately after the birth of the

head, the finger should be passed to the neck of the child in order to ascertain whether it is encircled by one or more coils of the umbilical cord. This complication occurs in about every fourth case, and the vessels are sometimes pressed upon so tightly that asphyxiation results. If such a coil be felt, it should be drawn down between the fingers, and, if

loose enough, slipped over the child's head; but if the cord be too tightly applied to permit of this procedure, and the head appears congested and suffused, the former should be seized and cut between two artery clamps, and the child immediately extracted.

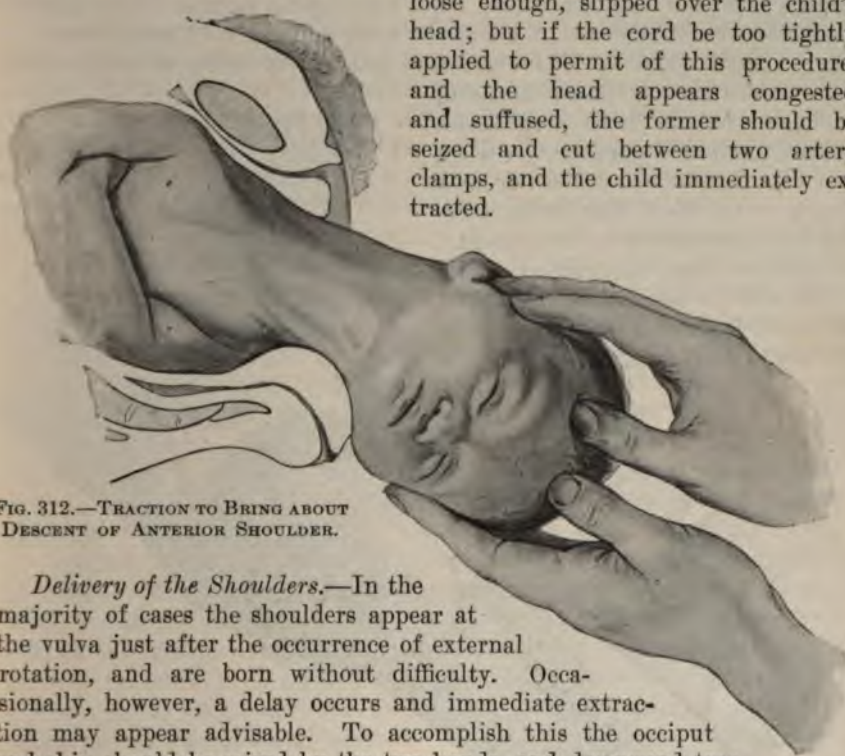


FIG. 312.—TRACTION TO BRING ABOUT DESCENT OF ANTERIOR SHOULDER.

*Delivery of the Shoulders.*—In the majority of cases the shoulders appear at the vulva just after the occurrence of external rotation, and are born without difficulty. Occasionally, however, a delay occurs and immediate extraction may appear advisable. To accomplish this the occiput and chin should be seized by the two hands, and downward traction made until the anterior shoulder appears under the pubic arch; next, by an upward movement, the posterior shoulder should be delivered, after which the other will usually drop from beneath the symphysis.

The body almost always follows the shoulders without difficulty, but in case of prolonged delay its birth may be hastened by traction upon the head, but not by hooking the fingers in the axillæ, since by the latter procedure the nerves of the arm may be injured and transient or permanent paralysis result. Indeed, even when the former method of extraction is employed, traction should be exerted only in the direction of the long axis of the child, for if it be made obliquely the neck will be bent upon the body, when excessive stretching of the brachial plexus on its convex side may occur, with subsequent paralysis.

*Tying the Cord.*—Immediately after its birth the child usually makes an inspiratory movement and then begins to cry. In such circumstances it should be placed between the patient's legs in such a manner as to leave the cord lax, and thus avoid traction upon it. If, however, the child



does not begin to breathe immediately, the cord should be seized and cut between two artery clamps, and efforts at resuscitation commenced at once.

Normally, the cord should not be ligated until it has ceased to pulsate. In securing it, a ligature of sterilized bobbin should be applied 2 centimeters from the abdomen of the child and tightly tied; a second ligature is placed several centimeters above the first, and the cord cut between the two. Usually ligation of the maternal end merely serves to avoid soiling the bedclothes by blood escaping from it; but in twin pregnancies double ligation is essential, for when the two *fœtuses* are derived from a single ovum there may be such extensive anastomoses in the placental circulation that the second child, while still in the uterus, may bleed to death from the maternal end of the cord of the first.



FIG. 313.—DELIVERY OF POSTERIOR SHOULDER.

The question as to the proper time for tying the cord has given rise to a great deal of discussion. Formerly it was the custom to ligate it immediately after the birth of the child; but Budin showed that 92 cubic centimeters more blood escaped from the maternal end of the cord after early than after late ligation,

thus indicating that that amount was lost to the *fœtus* by early ligation. Schücking demonstrated the same fact by weighing the child just after birth and again after the cord had ceased to pulsate. Budin believed that this amount of blood was drawn into the circulatory system of the *fœtus* by thoracic aspiration, while Schücking held that it was driven into it as a result of the compression of the placenta by the contracting uterus. Hofmeier, Zweifel, and Ribemont have also shown that the initial loss of weight in the first few days after birth is usually less after late than after early ligation.

I have always practiced late ligation of the cord and have seen no

injurious effects following it, and therefore recommend its employment, unless some emergency arises which calls for earlier interference.

After ligation of the cord, the child should be wrapped in a piece of flannel or blanket prepared for the purpose, and laid in a safe place until the placenta is born and the mother has been cleaned up and made comfortable.

*Anæsthesia.*—We are indebted to Sir James Y. Simpson for the introduction of anæsthesia into obstetrical practice. He employed ether for this purpose in the year 1847, and replaced it by chloroform after he had discovered the anæsthetic properties of the latter drug. Every one agrees as to the marked benefits derived from anæsthesia when operative procedures are to be undertaken, but there is still considerable difference of opinion as to the advisability of its routine employment in normal labor.

The most popular anæsthetics are ether and chloroform, and when obstetrical operations are to be performed it makes very little difference which is employed, as it is well known that the dangers incident to chloroform are markedly reduced at the time of labor, and that only a very few deaths have followed its use under such circumstances. It should, however, be remembered that this immunity is limited to the parturient woman, and does not exist either during pregnancy or the puerperium, when chloroform is quite as dangerous as at other times. Exactly why this immunity should exist is a question which has not yet been definitely settled, but it is nevertheless a fact which has been established beyond peradventure.

Generally speaking, chloroform is preferable in normal labor, for by its use obstetrical anæsthesia can be rapidly and safely produced; whereas ether, owing to its slower action, does not lend itself so readily to this method of employment. As the result of my experience, I believe that chloroform, when properly administered, is practically devoid of danger, and should be used whenever there is time for its administration. Of course it is contraindicated when the patient has religious scruples against its use, as well as in those cases in which labor is almost painless.

The choice of the time for its administration, however, is of great importance, nor should it be used before the latter part of the second stage, when the head becomes visible at the vulva, or at least until the perineum begins to bulge. A few drops of chloroform should then be poured upon the inhaler, and with the beginning of a pain the patient should be instructed to breathe in the fumes vigorously; but as soon as the contraction has ceased the inhaler should be removed, to be used again when the patient makes a sign that she feels the first indication that another is beginning. When the distention of the vulva is at its maximum, obstetrical anæsthesia is not sufficient to abolish the pain, and it is my practice, as the head emerges, to render my patient completely unconscious for the moment by increasing the dose of the drug.

By this procedure the woman is saved an immense amount of unnecessary pain, and at the same time the danger of perineal laceration is diminished. For, if the suffering is minimized, and done away with entirely at the critical moment, the patient will lie still instead of tossing in her bed,



does not begin to breathe immediately, the head being suddenly expelled cut between two artery clamps, and effort is then employed in employing his energies once.

Normally, the cord should not be ligated at the perineum. The amount of In securing it, a ligature of sterilized is very small, and rarely exceeds 2 meters from the abdomen of the child.

is placed several centimeters above the should be deferred as long as possible. Usually ligation of the maternal end is in the first, stage, unless external the bedclothes by blood escaping is prevented. Leaving out of consideration from it; but in twin pregnancies the necessity of the uterine contractions, it double ligation is essential, for when the patient has experienced the soothing the two foetuses are derived from a single ovum to do without it, and, once having single ovum there may be such extensive anastomoses in the placental circulation that the second child, while still in the uterus, may bleed to death from the maternal end of the cord of the first.



FIG. 313.—DELIVERY OF POSTERIOR SHOULDER.

tion, thus indicating that that Schücking demonstrated the and again after the cord has amount of blood was drawn racic aspiration, while Schück the compression of the placenta, and Ribemont have also few days after birth is used.

I have always practiced

tics in labor, it has been urged to death from the maternal end of the cord of the first. This statement is based for any great length of time of the uterine contractions and to them, as was clearly demonstrated Heusen. On the other hand, when in no excessive amount, this observation instances small doses even appear and, by diminishing the sensation of abdominal muscles into full play, which is to do, and thus hasten the completion.

anesthesia predisposes to relaxation of the placenta, and thus increases the So far as my own experience goes, provided the drug has been properly must be admitted that its prolonged and uterine inertia, and is not without child.

while diminishing the pain, appears conditions it should be discontinued necessary. It should never be used in the the hope of hastening the dilatation of attained by the proper administration

ed to come from under the influence of is born, as its exhibition is not necessary at when the placenta is to be removed laceration is to be repaired. Moreover, for the birth of the child the patient does when in active labor.

ing the rehabilitation by Bier of the subfor the production of anæsthesia of the

lower portion of the body, and its popularization by the work of Tuffier, it was but natural that its efficiency should be tested upon the parturient woman.

The first publication concerning its employment at the time of labor was made in August, 1900, by Kreis, who reported the results obtained in 6 cases in Bumm's clinic in Bâle. Since then a number of observers have reported series of cases treated in this manner with cocaine or some of its derivatives, and their work was well summarized by Müller in 1905. From their reports, as well as from observations made in my clinic, there is no doubt that most striking results are obtained in a certain proportion of cases.

In favorable cases, the patient being in the second stage of labor, the injection into the lumbar portion of the vertebral canal of 10 to 15 minims of a 1 per cent. solution of cocaine (1/10 to 1/6 grain) is followed within a few minutes by complete abolition of painful sensations. At the same time, the patient continues to make visible expulsive efforts with great regularity and oftentimes with increased frequency, so that, if the effects of the drug do not wear off too rapidly, the child may be expelled without pain and almost without the knowledge of the patient. Likewise, various operative procedures, such as manual dilatation of the cervix, version, or forceps, may be painlessly performed.

Notwithstanding these very wonderful results, I do not hesitate to advise strongly against the employment of the method, and therefore shall not enter into the details of the technique of making the injection. In the first place, the results are not always uniform, a certain number of patients appearing to be absolutely refractory to the influence of the drug when administered in doses consistent with safety. Again, its effects are sometimes very transient and fade away just when most needed. More serious, however, are the after-effects, the majority of patients suffering severely from headache and nausea, and frequently from an alarming, but transient, elevation of temperature. In view of their comparatively short duration, such symptoms are usually regarded as a manifestation of intoxication, rather than of infection.

The most serious objection to the method is the fact that Hahn, in 1901, reported 8 deaths in 1,708 cases in which its use has been recorded in the literature. No doubt, in several instances the fatal issue could not be fairly attributed to the method, but in several others the autopsy showed lesions of the spinal or cerebral meninges which could be due only to infection.

*Scopolamine-morphine Anæsthesia.*—This method of combating the pain of labor was introduced by Steinbüchel in 1902, and soon tried in this country by C. M. Greene. The former reported that the hypodermic injection of 0.0003 gram of scopolamine hydrobromate and 0.01 gram of morphia gave most satisfactory results and practically annulled the pains of labor, even permitting the application of forceps or the artificial dilatation of the cervix. Numerous reports have since been made of its more or less satisfactory employment in small series of cases.

In 1907 Gauss reported its administration in 1,000 cases in Krönig's



clinic in Freiburg, and stated that by a proper regulation of dosage 80 per cent. of the patients would pass into a semiconscious state, which he designated as "Dämmer Schlaf." In this condition the patient appears to appreciate pain at the time, but has no recollection of it later. For this purpose he administers 0.0003 gram of scopolamine and 0.01 of morphia hypodermically, and repeats the *scopolamine*, but not the morphia, once or twice later if necessary. The indication for its repetition is not afforded by the lapse of any specified length of time, but rather by the mental condition of the patient, who should be kept in a state of relative amnesia. This is determined by showing her some object, which she should promptly forget having seen, if sufficiently under the influence of the drug, but another dose should be administered if she possess any recollection of it thirty or thirty-five minutes later.

A very considerable literature has accumulated upon the subject, which was well summarized by Bosse and Eliasberg in 1910, and Lequeux in 1911. The former reported favorable results in 60 per cent. of their cases, while the latter concludes that only about one-half of the authors are thoroughly satisfied with their results. I have had no experience with the method, but conclude from my reading that the maternal results are not uniformly satisfactory, while a considerable number of children are born in an apnœic condition, and often require vigorous efforts at resuscitation.

*Hypnotism.*—Numerous observers, among whom may be mentioned Leichstein, Cocke, Matwjeew, and others, have reported instances in which labor was painlessly conducted under the influence of hypnotism. Personally I have seen it employed successfully in only a single instance. As a rule, its field of usefulness in obstetrics is very limited, for the reason that the patient must be a susceptible subject, and one who has already been hypnotized on previous occasions.

*The Use of Ergot.*—Many authorities recommend the administration of a dram of fluid extract of ergot by the mouth immediately after the expulsion of the placenta, as a prophylactic measure against post-partum hæmorrhage. This is usually unnecessary, as the drug is called for only in those cases in which the uterus remains soft and flabby, instead of forming a hard tumor beneath the umbilicus. When its employment is indicated, I always administer it hypodermically, and have found the ergotol prepared by Sharp and Dohme preferable to the officinal fluid extract, inasmuch as it is less likely to produce an abscess at the point of injection. Instead of being inserted just under and parallel to the skin, the needle is plunged deeply into the muscle of the thigh, and from 40 to 60 minims are injected, the dose being repeated if necessary. It should be remembered that such injections usually give rise to a slight but painful induration, which persists for several days, but only exceptionally eventuates in abscess formation.

I must insist once more that this is the only time at which ergot should be employed in labor, as its administration before the completion of the third stage has led to untold harm. Formerly, even well-trained physicians used it in large quantities during the second stage to stimulate

uterine contractions, but at the present time it is so employed only by ignorant midwives. The danger lies in the fact that the premature use of the drug readily leads to tetanic contractions of the uterus, which in the presence of any marked disproportion between the size of the child and pelvis are likely to bring about rupture of the uterus. Moreover, its administration in the third stage of labor, before the expulsion of the placenta, cannot be too strongly deprecated, as the resulting tetanic contraction tends rather to produce a further retention of the organ, so that its manual removal frequently becomes imperative.

**Conduct of the Third Stage of Labor.**—This subject has already been considered in the preceding chapter.

*Repair of the Lacerated Perineum.*—Strictly speaking, this subject should be deferred until the obstetrical operations are dealt with; but as perineal tears are of such frequent occurrence, and as they are best repaired in the interval between the birth of the child and the expulsion of the placenta, the proper method of procedure will be considered at this time.

For convenience in description, perineal tears are divided into three groups, those of the first, second, and third degrees. To the first belong those which involve simply the fourchette and anterior margin of the perineum, giving rise to a small, triangular wounded surface which is rarely more than 1.5 centimeters deep.

In the second the laceration extends through a greater or lesser portion of the perineal body, and frequently exposes the sphincter ani muscle. Usually its course does not quite follow the median line, but is directed obliquely downward and outward from the posterior margin of the vulva. The perineal tear is usually associated with lesions of the vagina, which extend up one or both sulci, so that a triangular portion of the vaginal mucosa, which represents the inferior extremity of the posterior column, may become separated from the rest of the canal.

In the third degree, the tear extends completely through the perineal body and the sphincter ani muscle, and for a certain distance up the anterior wall of the rectum, thus giving rise to a cloaca, into which both vagina and rectum open. These are designated as complete, in contradistinction to those of the first and second degrees—the incomplete tears—in which the rectum is not involved. Incomplete tears are encountered very often, even in the practice of the most competent obstetricians, no matter what precautions may be taken to prevent them; but the frequent occurrence of the complete variety indicates that the method employed for protecting the perineum has been at fault in spontaneous, or that the extraction has been too forcible or hasty in operative, deliveries.

In tears of the first degree, the mucous membrane of the fourchette and the skin covering the upper portion of the perineum and the subcutaneous tissue are implicated; in those of the second degree the skin surface of the perineum, the various perineal muscles, particularly the constrictor vaginae and transversus perinei, are torn through, and the wide gaping wound is due in great part to the retraction of the last-named muscles. When the tear extends up the vagina, the levator ani muscle



is likewise involved; while, in lacerations of the third degree, the sphincter ani muscle and the anterior surface of the rectum are implicated in addition to the structures above named.

As has been said, the perineal tear commences, as a rule, at the four-



FIG. 314.—SUPERFICIAL PERINEAL TEAR.



FIG. 315.—DEEP PERINEAL TEAR.

chette and extends obliquely downward and outward from it. But in the very rare cases in which the vulval outlet looks markedly upward, or in which the perineum is extremely resistant and the mechanism of expulsion faulty, the laceration may begin in the central portion of the perineum, when the head appears in an opening which is surrounded on all sides by skin. This is known as a *central tear*, and is of extremely infrequent occurrence. Ordinarily, as the head is forced down still farther, the central tear extends toward the fourchette or toward the anus, or even in both directions, and thus gives rise to a deep incomplete, or to a complete laceration, as the case may be.

In not a few cases, where the vaginal opening is very resistant, and when the head has remained a long time upon the pelvic floor, even although there may be no external wound or appreciable lesion of the vagina, there may nevertheless have occurred a submucous tear or separation of certain fibers of the levator ani muscle, which will later give rise to a marked relaxation of the vaginal outlet. Not infrequently the condition, although unrecognized at the time, later gives rise to such aggravated symptoms as to call for operation years after the birth of the child.

No matter what the degree, the *immediate closure of perineal lacerations* by suture is urgently indicated. Even slight tears through the fourchette

are better repaired than left alone, for if not united by suture they are often extremely painful, and furnish a nidus for infection in case the nurse is lax in her care of the patient. In more extensive tears immediate repair is always necessary, unless the condition of the patient be so serious as to contraindicate further operative procedures.

For these operations, the patient should be brought to the edge of the bed and placed in the lithotomy position, and the sutures introduced while waiting for the expulsion of the placenta. They should not be tied until the completion of the third stage, as the distention of the vulva by the placenta may subject the repaired wound to undue strain. By introducing the sutures during this period a good deal of time is saved, and the temptation to hasty expression of the placenta is diminished, since the physician has plenty to do while waiting for the fundus to rise up.

The mode of repairing the wounded perineum differs according as the tear extends only through the perineal body or is complicated by lacerations of the vagina or rectum. In the first case, the wound should be closed by deep sutures of silkworm gut, which are introduced at least 0.5 centimeter from one margin and carried well down under its base, being then brought out through the skin surface on the opposite side. It is important that the sutures should be inserted and emerge at a considerable distance from the edges of the wound, for, owing to the marked œdema which frequently develops a day or so later, they are very prone to tear through unless this precaution be taken. They should be placed at intervals of about 1 centimeter, and if accurate approximation is not secured in this way superficial sutures should be employed between them. Large curved needles, which can make the entire sweep at a single movement, should be used, as they render much better service than small needles which require several bites. The sutures should be tied very loosely from below upward, and cut off short.

As a suture material, silkworm gut should be chosen for deep sutures. Silk sutures are objectionable, as they readily become impregnated with the lochial secretion and are more likely to favor infection of the wound. Ordinary, or even chromicized, catgut is not satisfactory for deep sutures, as it is too rapidly absorbed, owing to the fact that the exposed portions are kept moist by the lochia. The latter is very useful, however, for superficial sutures, which are only required to remain for a short time.



FIG. 316.—COMPLETE PERINEAL TEAR.



When the perineal tear is complicated by laceration of the vagina, the edges of the latter should be brought together by chromicized catgut sutures, just as in Emmet's relaxed outlet operation. These may be either interrupted or continuous, but in either event they should be laid deeply in order to insure coaptation of the torn structures of the pelvic floor, instead of merely bringing together the edges of the mucosa, after which the perineal wound should be repaired in the usual manner.



FIG. 317.—NEEDLE FOR REPAIRING PERINEAL TEARS.

In complete tears, attention should first be given to the wounded rectum and its ruptured mucosa united by buried catgut sutures. Then the ends of the sphincter ani should be isolated and firmly sutured by catgut or fine silk sutures, after which the vaginal and perineal tears should be dealt with in the manner indicated above.

The after-treatment of tears of all degrees is comparatively simple, and consists in keeping the wound clean and covered by sterile dressings. Whenever the latter are changed the wounded surface should be washed with a 1 to 4,000 bichloride solution for a few days, and later with one



FIG. 318.—NEEDLE HOLDER.

of boric acid. The continuous use of antiseptic powders, such as iodoform or boric acid, is not indicated, as the wounds heal equally well without them. Nor is there any necessity for binding the legs together, unless the patient is very unruly and refuses to keep still. Catheterization may also be dispensed with, except in cases of retention, as the flow of urine over the wound does no harm, provided it is followed by proper cleansing. Generally speaking, the external sutures should be removed on the tenth day. In tears of the first and second degrees the bowels should be moved daily, but in complete lacerations it is advisable to prevent an action for the first three or four days, after which a large high enema of sweet oil should be given, followed by calomel or castor oil by the mouth.

The results following these operations are usually very satisfactory, and, when the parts have been correctly approximated, primary union is the rule, provided the sutures have been introduced far enough from the margins of the wound and not tied too tightly. This is a point to which too much attention can hardly be paid, for too often there is a tendency to attempt to make a neat-looking operation by introducing the sutures close to the margins of the wound and tying them snugly. As a result of this short-sighted policy, however, owing to the oedema which usually follows, the majority of the stitches cut through and become useless, so that union

by primary intention becomes impossible. On the other hand, when less attention is paid to the first appearance of the wound, the sutures being introduced far from its margins and tied somewhat loosely, excellent results almost always follow.

Unfortunately, operations for complete tears are by no means so satis-



FIG. 319.—REPAIR OF PERINEAL TEAR  
EXTENDING UP THE VAGINA.



FIG. 320.—SAME, SUTURES TIED.

factory, and, as a general rule, not more than two-thirds of the cases heal by first intention. In the cases of complete or partial failure a secondary operation is indicated before the patient is discharged from treatment.

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## CHAPTER XVI

### THE PUERPERIUM

Strictly speaking, the term puerperium or puerperal state (from puer, a child; and parere, to bring forth) comprises the period elapsing between the onset of labor and the return of the generative tract to its normal condition; but in common parlance it is restricted to the five or six weeks following the completion of labor. Although the changes occurring during this period are considered as physiological, they border very closely upon the pathological, inasmuch as under no other circumstances does such marked and rapid tissue metabolism occur without a departure from a condition of health.

**Anatomical Changes in the Puerperium.**—*Involution of the Uterus.*—Immediately following the expulsion of the placenta, the contracted and retracted body of the

uterus forms a hard muscular tumor, the apex of which lies about midway between the umbilicus and symphysis, usually 12 centimeters ( $4\frac{3}{4}$  inches) above the latter. At autopsy, shortly after labor, it consists of an almost solid mass of tissue containing in its center a flattened cavity, whose walls are in close apposition, measure four to five centimeters in thickness, and present

a markedly anæmic appearance as compared with those of the pregnant organ. The latter is due, according to Webster and Longridge, to compression of its vessels by the contracted and retracted muscular fibers, which at the same time express a considerable portion of the tissue juices. During the next two days the uterus remains apparently stationary in size, after which it atrophies so rapidly that by the tenth day it has descended into the cavity of the true pelvis, and can no longer be felt above the sym-



FIG. 321.—FROZEN SECTION, SHOWING UTERUS IMMEDIATELY AFTER DELIVERY (Webster).



physis. It reaches its normal size by the end of five or six weeks. Some idea of the rapidity with which the process goes on may be gained by recalling the fact that the freshly delivered uterus weighs about 1,000 grams, one week later 500 grams, at the end of the second week 375 grams, and at the end of the puerperium only 40 to 60 grams.

This rapid decrease in size is due to what is designated as *involution*, and is the most striking example of atrophy with which we are acquainted; in that the organ becomes reduced to one-twentieth or one-twenty-fifth of its original size within a few weeks, and, when compared with the changes occurring in acute yellow atrophy of the liver, may well be designated as "atrophia acutissima."

It was formerly believed that the muscle cells underwent fatty degeneration during involution, and that large numbers of them completely disappeared. The researches of Sanger have shown, however, that only the excess of protoplasm is removed, and that the actual number of individual cells is not materially diminished. In other words, they undergo marked atrophy, but are not destroyed. Sanger estimated that their average length in the full-term uterus was 208.7 microns, as compared with 24.4 microns five weeks after labor.

It is now held that involution is effected by autolytic processes, by which the protein material of the uterine wall is in great part broken down into simpler components, which are then absorbed and eventually cast off through the urine. The evidence in favor of such a view is principally afforded by the study of the nitrogen content of the urine. For the twenty-four hours immediately following labor 7 to 9 grams of nitrogen are excreted, but some time during the second or third day an increase of 30 to 50 per cent. is noted. This excessive output continues for a number of days, but gradually returns to normal at about the time the uterus has disappeared into the pelvic cavity.

That this phenomenon is not entirely attributable to the removal of other products of pregnancy was clearly shown by Slemmons, who, in one of my patients, from whom the uterus had been removed at Cæsarean section, found that the characteristic increase in the nitrogen output was lacking, and practically corresponded to the quantity of nitrogen found upon analyzing the uterus.

As yet we know nothing of the ferments giving rise to the autolysis, but it is readily conceivable that their action is facilitated by the acute anæmia of the "blood-tight" uterus. Longridge, who has studied the metabolism of the puerperium, found that the creatinin content of the urine remained normal, which indicates that none of the uterine nitrogen escapes in that form.

As has been said before, the separation of the placenta and its membranes occurs in the inner portion of the spongy layer of the decidua, and accordingly a remnant of the latter remains in the uterus after their expulsion. It presents an irregular, jagged appearance, and is markedly infiltrated with blood, especially at the placental site. As the result of hyalin and fatty degeneration, the greater portion of this tissue is cast off in the lochia, leaving behind only the fundi of the glands and a mini-

mal amount of connective tissue, from which the new endometrium is regenerated.

The processes concerned in its regeneration have been carefully studied by Friedländer, Kundrat and Engelmann, Leopold, Krönig, and particularly by Wormser. The latter has shown that, within two or three days after labor, the portion of decidua remaining in the uterus becomes differentiated into two layers—one adjoining the uterine cavity being necrotic, and the other adjoining the muscularis being well preserved. The former is cast off in the lochia, while the latter, which contains the fundi of the glands, remains *in situ* and constitutes a matrix from which the new endometrium is regenerated, its epithelium resulting from the proliferation of the gland cells, and its stroma from the connective tissue between them. For the first ten days or two weeks degenerative processes predominate, but after that mitotic figures appear and regeneration is rapid, the new endometrium being fully formed by the end of the third week, except at the placental site, where the process is more gradual.

*Changes in the Uterine Vessels.*—Immediately after the completion of the third stage of labor, the placental site is represented by an irregular, nodular, elevated area of about the size of the palm of the hand, the elevations being due to the presence of thrombosed vessels. This area decreases rapidly in size, so that it measures 3 or 4 centimeters in diameter at the end of the second week, and only 1 to 2 centimeters at the completion of the puerperium, although it still remains elevated above the general surface of the interior of the uterus and is tinged with blood pigment. Its original position remains recognizable for quite a long period, and even six months after childbirth appears as a slightly elevated pigmented area.

In the last month of pregnancy some of the sinuses at the placental site undergo thrombosis, but the process becomes more marked in the latter portion of the second and particularly after the completion of the third stage of labor, although many sinuses never become thrombosed, but are simply compressed by the contracting uterine muscles. The thrombi become organized by the proliferation of the intima of the vessels, and eventually are converted into typical connective tissue.

As the non-pregnant uterus requires a much less abundant blood supply than the pregnant organ, it is apparent that the lumina of its various arteries must undergo a certain amount of constriction. Formerly it was thought that this was brought about by a *compensatory endarteritis*, which disappeared in subsequent pregnancies. Now, however, the prevailing belief is that the larger vessels are completely obliterated by hyalin changes, and that new and smaller vessels develop in their stead. The absorption of the hyalin material is accomplished by processes similar to those observed in the ovaries, although the changes may persist for years, and under the microscope offer a ready means of differentiating between the uteri of women who have, and those who have not, borne children. For details, the student is referred to the articles of Pankow, Goodall, and Büttner.

*Changes in the Cervix, Vagina, and Vaginal Outlet.*—Immediately af-



ter the completion of the third stage, the cervix is represented by a soft, muscular tube, whose boundaries can be made out only with difficulty. The margins of the external os are soft and flabby, and are usually marked by depressions indicating the seat of lacerations. Its opening contracts slowly. For the first few days immediately following labor it readily admits two fingers, but by the end of the first week it has become so narrow as to render difficult the introduction of one finger. At the same time the lower uterine segment collapses, and what remains of the contraction ring comes in contact with the upper portion of the cervical canal. As Webster has pointed out, there is no doubt that the structure which is usually taken for the internal os on digital examination really represents the lower margin of the contraction ring (Fig. 322).

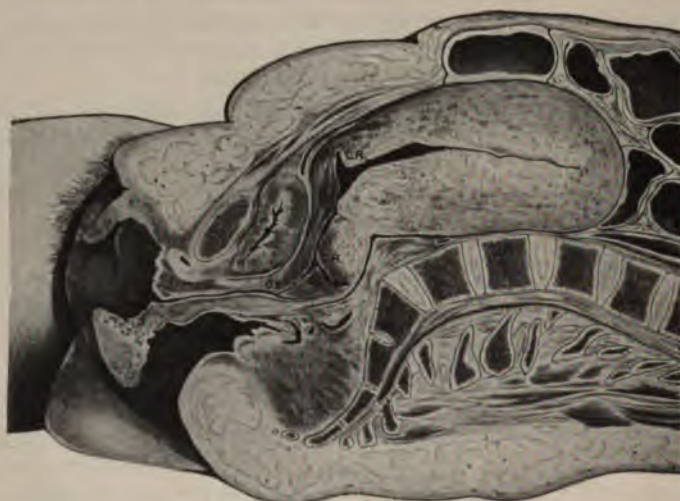


FIG. 322.—FROZEN SECTION JUST AFTER COMPLETION OF THIRD STAGE OF LABOR, SHOWING COLLAPSE OF LOWER UTERINE SEGMENT AND CERVIX (Benckiser).

*C.R.*, contraction ring; *O.E.*, external os; *O.I.*, internal os.

The vagina requires some time to recover from the distention to which it has been subjected. In the first part of the puerperium it is represented by a large, smooth-walled passage, which gradually diminishes in size, though it rarely returns to its virginal condition. The rugæ begin to reappear about the third week. The vaginal outlet is also markedly distended, and frequently bears signs of more or less extensive laceration. The hymen, as such, has disappeared, and its place is taken by a number of small tags of tissue, which, as the process of cicatrization goes on, become converted into the *carunculæ myrtiformes*, which are characteristic of the vaginal opening of parous women. The labia majora and minora become flabby and atrophic, as compared with their condition before childbirth.

*Changes in the Peritoneum and Abdominal Wall.*—While these changes are taking place in the uterus and vagina, the pelvic peritoneum and the

structures of the broad ligaments are accommodating themselves to the changed condition of affairs. For the first few days after labor the peritoneum covering the uterus is arranged in folds, which soon disappear. The broad and round ligaments are much more lax than in the non-pregnant condition, and require considerable time to recover from the stretching and loosening to which they have been subjected.

As a result of prolonged distention due to the presence of the enlarged pregnant uterus, the abdominal walls remain soft and flabby for some time. Except for the presence of silvery striae, they gradually return to their normal condition if the abdominal muscles have retained their tonicity; but when this is markedly impaired they never regain their original consistency, but remain lax and flabby. In not a few instances, particularly in women who have borne a number of children in rapid succession, there may be a marked separation or *diastasis of the recti muscles*, so that a considerable portion of the abdominal contents is covered simply by peritoneum, thinned-out fascia, and skin.

The changes occurring in the breasts are very characteristic, and will be considered in Chapter XVII.

**Clinical Aspects of the Puerperium.**—*Post-partum Chill.*—Quite frequently the patient may have a more or less violent rigor, coming on shortly after the completion of the third stage of labor. This is purely a nervous or vasomotor phenomenon, and is without prognostic significance. In this respect it stands in marked contrast to a chill occurring later in the puerperium, which nearly always indicates the onset of an acute infectious process or the recrudescence of a malarial attack.

*Temperature.*—The temperature should remain practically normal during the puerperium; hence any considerable rise should always be considered as a sign of infection, until convincing evidence to the contrary can be adduced. Occasionally the temperature may become slightly elevated toward the end or just after the completion of a difficult labor, but rarely goes above 100.4° F. (38° C.), usually falls to normal within twelve hours, and does not rise again. A higher temperature during labor in all probability indicates infection of the liquor amnii.

Owing to the fact that slight rises of temperature occur frequently during the puerperium without apparent cause, it is customary to designate as normal all puerperia in which the temperature remains below 100.4° F. (38° C.), and as febrile all those in which that limit is reached or exceeded, even upon a single occasion.

It was formerly believed that the establishment of the lacteal secretion on the third or fourth day of the puerperium was naturally attended by a slight rise in temperature. Indeed, so prevalent was this idea that in pre-antiseptic times the so-called *milk fever* was regarded as a normal phenomenon. But at present we no longer believe in the existence of such a pathological entity, and whenever the temperature exceeds the arbitrary normal limit at this time the conscientious obstetrician should fear the beginning of an infection, and begin to look for the errors of technique which may have led to it.

*Pulse.*—During the puerperium the pulse is usually somewhat slower



than at other times, averaging between 60 and 70. In nervous women, however, and in those who have had difficult labors or have suffered any considerable loss of blood, a more rapid rate than normal is not infrequent. In a certain number of cases, a day or two after the birth of the child, the pulse becomes markedly slower, and not infrequently falls to 50, 40, or even fewer beats to the minute. Fehling has reported a case in which the rate was only 36.

Ordinarily this phenomenon becomes most marked on the second or third day, after which the pulse becomes quicker and attains its normal rate by the end of the first week or ten days. The slow pulse is usually regarded as a favorable prognostic sign, whereas a rapid heart action, unless it can be accounted for by hæmorrhage or cardiac disease, should be looked upon with suspicion.

This puerperal bradycardia is usually regarded as a characteristic phenomenon. Heil, however, in 1898, stated that he observed it in only 12 per cent. of his cases. He affirmed that if the pulse be carefully counted in the same patient for some days before, as well as after, labor, it will usually be found slightly quicker in the puerperium than during pregnancy. Varnier's investigations failed to confirm Heil's conclusions, since they showed that the puerperal slow pulse occurred in 72 per cent. of the cases. In a series of patients in my service, reported by Lynch, in which the pulse rate was recorded during pregnancy as well as during the puerperium, a slowing of ten or more beats per minute was noted in 20.5 per cent., and occurred more than twice as frequently in multiparous as in primiparous women.

Numerous theories have been advanced from time to time in the attempt to explain its mode of production, but none of them are wholly satisfactory. It is not impossible that the solution is quite simple, and that the condition may depend upon two factors: the absolute rest of the patient in bed, together with the great diminution in work which the heart is called upon to perform after the elimination of the utero-placental circulation. Kehrer attributed the slowing in great part to the lowering of the blood pressure following delivery; Schroeder, to the sudden diminution of the vascular area after the utero-placental circulation is thrown out of function; Fritsch, to the horizontal position and rest in bed; Löhlein, to stimulation of the vagus or other nervous influences; Olshausen, to the absorption of various products set free in the blood during the involution of the uterus; and Novak and Jetter, to vagus stimulation.

*Changes in the Blood.*—It is usually stated that there is a slight decrease in the number of red corpuscles and the amount of hæmoglobin immediately after delivery. This is attributable to the loss of blood at the time, and is usually compensated for within the first week, after which the normal condition is restored.

Hofbauer has directed attention to the occurrence of a marked leukocytosis occurring during and just after labor. He showed that the leukocytes gradually increase in number from the onset of labor and reach a maximum ten or twelve hours after its conclusion, at which time they are nearly twice as abundant as during pregnancy. Having attained their acme, they



promptly fall to normal, rising again slightly on the third or fourth day, with the establishment of the lacteal secretion, after which they remain at the normal level.

*After-pains.*—In primiparous women the uterus remains in a state of tonic contraction and retraction during the puerperium, unless it has been subjected to unusual distention, or blood-clots or other foreign bodies have been retained in its cavity, as a consequence of which active contractions occur in the effort to expel them. In multiparous women, on the other hand, the uterus has lost part of its initial tonicity, so that persistent contraction and retraction cannot be maintained, and it therefore contracts and relaxes at intervals, the contractions giving rise to painful sensations, which are known as after-pains, and which occasionally are so severe as to require the administration of a sedative. In many patients these are particularly noticeable when the child is put to the breast, and may last for many days, but ordinarily they lose their intensity and become quite bearable after the twenty-four hours immediately following delivery.

*Lochia.*—During the first part of the puerperium there occurs normally a variable amount of vaginal discharge—the lochia. For the first few days after delivery it consists of blood-stained fluid—*lochia rubra*; after three or four days it becomes paler—*lochia serosa*; and after the tenth day, owing to a marked admixture with leukocytes, it assumes a whitish or yellowish-white color—*lochia alba*. It is alkaline in reaction, and has a peculiar fleshy odor, suggesting fresh blood. In normal cases its total quantity varies between 500 and 1,000 grams, being less profuse in those who suckle their children. Foul-smelling lochia indicate infection with putrefactive bacteria. In many instances the reddish color is preserved for several weeks, but when it persists for a longer period it indicates imperfect involution of the uterus, or the retention of portions of the after-birth. When examined under the microscope during the first few days, the lochia consist of red blood-corpuscles, leukocytes, fatty epithelial cells, and shreds of degenerated decidual tissue.

Micro-organisms can always be demonstrated in the discharge gathered at the vulva, but are not always present when it is obtained from other portions of the generative tract. The investigations of Döderlein, Krönig, Döderlein and Winternitz, Little, and myself have shown that normally the lochia obtained directly from the uterine cavity do not contain bacteria during the first few days of the puerperium, but that they occur with increasing frequency as it advances. They are not, however, of the pyogenic varieties, except in cases of infection. Krönig has demonstrated that the normal vaginal lochia, although rich in harmless parasites, do not contain pyogenic organisms, with the exception of gonococci. The same investigator also showed that the bacterial flora of the vagina undergoes a marked change during the puerperium, when the bacilli, which predominate during pregnancy, are in great part replaced by cocci. This change is probably due to the altered reaction of the secretion, which is markedly acid before, and alkaline after, labor.

*General Functions.*—The function of the skin is markedly accentuated during the puerperium, as is demonstrated by the profuse sweating which



frequently characterizes this period. It is most marked at night, and it is not unusual for the patient to awake from a sound sleep to find her nightgown drenched with perspiration. It passes off spontaneously and does not require treatment.

The appetite is usually diminished during the first few days after labor, and the patient experiences very little desire for nutritious food. At the same time, owing to the marked diaphoresis and the quantity of fluid lost through the lochial discharge, thirst is considerably increased.

The bowels are nearly always constipated during the first part of the puerperium. This is due partly to the fact that the patient eats but little solid food, but principally to the marked relaxation of the abdominal walls and their consequent inability to aid in evacuating the intestinal contents.

*Urine.*—There is a marked increase in the urinary output during the puerperium. More important, however, are the changes in the composition of the urine, which afford an index to the profound changes in metabolism which characterize this period. Almost immediately following labor, the total nitrogen increases to nearly double the amount excreted during pregnancy, while the ammonia nitrogen shows a steady decrease. The nitrogen output continues at a high level for several days and then gradually falls, reaching normal at the end of ten days or two weeks. As has already been indicated, this change is associated with the involution of the uterus.

In the majority of cases the examination of specimens of urine, removed by catheterization immediately after the completion of the third stage of labor, shows a slight amount of albumin and numerous hyalin casts, even though both may have been absent throughout pregnancy. In a series of patients studied in my service by Little, albumin was noted in 89 per cent., and casts in 41 per cent. This is a transient phenomenon resulting from the systemic strain caused by labor, and usually disappears within twenty-four hours, though in 31 per cent. of the cases traces of albumin persisted for some days, but always disappeared by the end of the second week, unless the patients were suffering from toxæmia or chronic nephritis.

Occasionally a small amount of sugar may be found in the urine during the first weeks of the puerperium, coincidently with the establishment of the lacteal secretion. Careful investigation shows that the reaction is due to the presence of lactose, or milk-sugar, which is supposed to be absorbed from the mammary glands, so that the condition has nothing to do with diabetes. Ney observed it in 77 per cent. of his cases, while McCann and Turner detected it in small quantities in every case which they examined. In my own clinic, the routine weekly urinary examination in 3,000 patients showed a much smaller incidence—4.69 per cent. For a full discussion of the question the reader is referred to my article on the clinical significance of glycosuria in pregnant women.

Couvelaire and Scholten have demonstrated that there is a marked increase in the amount of acetone in the urine immediately after labor, which disappears within the next three days. The last-named investigator noted it in 94 per cent. of his cases, and found that it was most abundant



after difficult and prolonged labors. He attributes its production to the excessive breaking up of carbohydrates resulting from the increased muscular activity incident to parturition.

There is a marked tendency toward retention of the urine during the first few days of the puerperium, and occasionally the distended bladder can be distinguished as a fluctuant tumor above the umbilicus. The retention may result from numerous causes, but is particularly apt to follow operative or difficult labors; and in such circumstances may be attributable to contusions or other slight lesions of the urethra. In other cases it is probably caused by the diminished intra-abdominal pressure, which allows a greater quantity of urine to accumulate in the bladder than under other conditions, as well as by the flaccidity of the abdominal walls and the consequent difficulty of bringing them into play during urination. In not a few cases it is due to the fact that possibly at any time the patient is unable to evacuate the bladder in the recumbent position.

*Loss of Weight.*—In addition to the loss of 6 to 6½ kilos, which results from the evacuation of the contents of the uterus, it is generally stated that there is a still further loss of body weight during the puerperium, which, according to Gassner, amounts to 4,500 grams in the first week. Heil estimates it at 2,000, and Klemmer at only 900 grams. This apparent contradiction is due to the fact that Gassner's results were obtained at a time when the diet was greatly restricted, but at present, when it is more liberal, the loss of weight is much less, and in many instances does not occur at all if sufficient food be taken. In normal cases it is nearly always regained by the end of the puerperium.

**Care of the Patient during the Puerperium.**—*Attention Immediately after Labor.*—After carefully examining the placenta immediately after its expulsion, to make sure that it is intact, the physician should devote his attention to watching the condition of the uterus. At this time it should form a hard, round, resistant tumor, whose upper margin lies below the umbilicus. As long as it resembles a cricket-ball in consistence, there is no danger of post-partum hæmorrhage. But if it becomes soft and flabby, there is imminent danger of such an occurrence, unless proper measures are taken at once to guard against it. For this purpose the uterus should be palpated through the abdominal walls immediately after the conclusion of the third stage, and if it is found to be firmly contracted the same manœuvre should be repeated at intervals of a few minutes. If, however, any tendency toward relaxation is detected, the organ should be grasped through the abdominal walls and vigorously kneaded until it remains persistently contracted; at the same time ergot should be administered hypodermically.

In normal cases, even although there may be no tendency toward hæmorrhage, the uterus should be palpated at intervals for the first hour after the expulsion of the placenta; but if satisfactory contractions do not occur at once, its behavior should be carefully watched for at least an hour after these have been induced. The physician should never leave the patient immediately after the completion of labor, even if it has been perfectly normal, but should remain within call for at least an hour, so as



to be ready should any complication arise. If the patient has a competent trained nurse, the duty of watching the uterus may be delegated to her; but the physician should not leave the house until he has made a final examination, and is satisfied that all reasonable danger of hæmorrhage has passed.

*Toilet of the Vulva.*—Immediately after the birth of the placenta, the soiled linen having been removed from beneath the patient, the buttocks and external genitalia are cleansed with hot water and soap and bathed with a 1-2,000 bichloride solution. A sterilized vulval pad, made of cotton wrapped in gauze, is then applied over the genitalia and held in place by a "T" bandage, being replaced by a clean one whenever necessary. The number of pads required in the twenty-four hours varies according to the amount of lochial discharge, and affords a fairly accurate means of estimating its quantity. Each time the pads are changed, and after each movement of the bowels, the genitalia should be washed with cotton pledgets soaked in bichloride solution. Ordinary sponges should never be used for this purpose. The parts should be washed from above downward, so as to avoid contamination from the rectum.

The vulval pad not only absorbs the lochia and prevents contamination of the vulva from without, but also makes it difficult for the patient to touch her genitalia, a practice very common among the uneducated classes, and one that occasionally gives rise to infection.

*Binder.*—Many authorities recommend that a tightly fitting binder of unbleached muslin, reaching from the trochanters to above the umbilicus, be applied immediately after delivery, since they hold that it exerts a beneficial effect upon the involution of the uterus, makes the patient more comfortable, and tends to restore her figure to its original condition. Personally, I am not in favor of its routine employment, as I am of the opinion that it occasionally gives rise to retroversion or retroflexion of the enlarged and soft uterus, especially if it be applied sufficiently snugly to exert compression. This objection, however, does not hold good after the organ has descended into the pelvic cavity—that is, after the tenth day. From this time on a well-fitting bandage can do no harm, and some patients find that it adds considerably to their comfort by supporting the lax abdominal walls when they first begin to sit up. Nor can I find any evidence of its value in restoring the figure, which will gradually return without its use, provided the tonicity of the abdominal muscles be retained; but when this is seriously impaired I know nothing that will bring about the desired result, although massage and gentle gymnastic exercises during the last week the patient spends in bed may do something toward it. As the dangers to be apprehended from the use of the binder are not great, it is perhaps as well to permit its use by those patients who feel strongly that it will aid in restoring the figure, for if it be forbidden the physician will probably be blamed in case a shapeless figure follows.

*After-pains.*—As after-pains usually occur in multiparæ, but only in primiparæ when the uterus has been subjected to undue distention, it is not usually necessary to provide for their treatment after the birth of the



first child. On the other hand, after the delivery of a multiparous patient, it is advisable to leave with the nurse several tablets of  $\frac{1}{4}$  grain of morphine and  $\frac{1}{150}$  grain of atropine, with instructions to administer them by the mouth at intervals of four or six hours, if the pains be severe.

*Rest and Quiet.*—As soon as the patient has been made comfortable, the room should be darkened and she should be encouraged to sleep. The relatives should be excluded, and the nurse should bathe and dress the baby in an adjoining apartment, if there is one at her disposal. The patient should be kept in bed for the first ten days, but should be permitted to move freely and to be propped up to eat her meals. During this period, as a rule, only the immediate members of the family should be admitted to see her. Moreover, if these are numerous, strict instructions should be given the nurse as to the number of visitors each day.

*Diet.*—Formerly it was the custom to restrict to a minimum the diet of the puerperal woman, and, as has already been said, this limitation goes far to explain the loss of weight which was frequently observed during the first few days. At present, however, a more liberal allowance is customary, and the patient is encouraged to take plenty of plain nourishing food.

If not nauseated, she should be given a glass of milk or a cup of tea soon after labor. For the first few days the appetite is not vigorous, but small quantities of easily digested food may be taken at frequent intervals. I usually give the nurse the following directions: For the first twenty-four hours, water, milk, coffee, tea, or cocoa, boiled or poached eggs, and buttered or soft toast. On the second and third days the same, with the addition of simple soups or bouillon, raw or stewed oysters, sweetbreads, chicken breast, and wine jelly. On the fourth and fifth days as above, with the addition of birds, steak, chops, baked potatoes, and rice, after which the ordinary diet should be gradually resumed.

*Temperature.*—The temperature should be carefully watched during the first week of the puerperium, as fever is usually the first symptom of the onset of an infectious process. If the patient be in charge of a trained nurse, it should be taken four times daily—at 8 a. m., 12 m., 4 p. m., and 8 p. m., and recorded upon a suitable chart. The physician should be immediately notified if it rises above  $100^{\circ}$ . But when the nurse is ignorant the temperature should be taken by the physician himself, morning and evening, for the first five days. This, of course, means that during that time he must visit the patient twice a day, once a day for the following two or three days, and afterward at less frequent intervals. But when the nurse is competent a single daily visit will suffice, unless untoward symptoms develop, as the physician can rely upon being notified promptly of any change. It is always better, however, whenever possible, that the patient should be seen within the first twelve hours following delivery.

*Urination.*—The patient should be encouraged to urinate within the first six hours. When she is unable to do so, the catheter should not be employed until the bladder forms a marked tumor above the symphysis, and not even then until the patient has attempted to urinate in a sitting



position; inasmuch as many women are unable to use a bed-pan. I consider the change in position much less dangerous than catheterization, as the latter, no matter how carefully performed, always carries with it some risk of infection and of a consequent cystitis, particularly as the investigations of Alsberg have shown that the normal urethra always harbors colon bacilli. Moreover, in not a few cases, the procedure, when once commenced, must be continued for a number of days, a condition of affairs which, leaving out of account the danger of infection, becomes very onerous to the physician, unless he has a competent nurse in charge.

When, however, catheterization becomes absolutely necessary, the genitalia having been first exposed and bathed with a bichloride or boric solution, a freshly boiled glass catheter should be introduced by carefully disinfected fingers; or, better still, it should be grasped with a piece of freshly boiled cotton, so as to prevent its coming in contact with the fingers at all. At the present day, to catheterize a woman under a sheet or by the sense of touch is not justifiable. If repeated catheterization becomes necessary, 5-grain tablets of urotropin should be administered four times daily as a prophylactic measure against cystitis.

*Bowels.*—In view of the sluggishness of the bowels in the puerperium, a mild cathartic should be administered on the morning of the second day, unless they have previously been evacuated spontaneously. For this purpose I generally employ half an ounce of Rochelle salts in a small quantity of water, half a bottle of the effervescent citrate of magnesia, or, if the patient will consent to take it, an ounce of castor oil.

After the preliminary cathartic, the bowels should be moved once daily. If a spontaneous action does not occur, the administration of the fluid extract of cascara at bedtime, in 20- to 60-minim doses, or 1 or 2 drams of the aromatic elixir, according to the susceptibility of the patient, is indicated. Sometimes a pill containing aloin, belladonna, and strychnine, or 1 to 2 teaspoonfuls of compound licorice powder, prove more satisfactory.

*Care of the Nipples.*—Details concerning the care of the nipples will be given in Chapter XVII, but the physician should be careful to impress upon the nurse the necessity of observing aseptic precautions in dealing with them; and she should be directed to report immediately the appearance of fissures, as their proper treatment will usually prevent mammary infection and the consequent danger of mastitis.

*Time for Getting Up.*—It is a time-honored custom to allow the puerperal woman to sit up on the tenth day. This rule, however, should not be slavishly followed, and every patient should be kept in bed until the fundus of the uterus has disappeared behind the symphysis pubis. This frequently occurs by the tenth day, occasionally a day or so earlier, but very often not until some days later. Generally speaking, a two weeks' rest in bed is not excessive.

Küstner advocated the practice of allowing the patient to get up on the third or fourth day, and states that he has seen no ill consequences follow such a procedure. His suggestion was promulgated before the German Gynecological Congress in 1899, and has found many followers, espe-

cially in Germany. No doubt it is feasible in most cases, but it has yet to be demonstrated whether it subserves the best interests of the patient. It is interesting to note that a similar suggestion was made by Charles White of Manchester as early as 1773, and 100 years later by Goodell of Philadelphia.

It is also advisable to give rigid directions as to the length of time the patient should remain out of bed. I have found it a convenient rule to direct that she should sit up for one hour on the first day, two hours on the second, and to increase the time by an hour each day until she is able to be up all the time. She should be kept in her room until the expiration of the third week, and allowed to move about on the floor on which she was confined during the fourth week. She should not be permitted to go downstairs until the expiration of this period, as it is a matter of experience that the average woman cannot be prevented from assuming the ordinary duties of her household after she has once gone downstairs; whereas as long as she is kept on one floor she is usually amenable to the direction of her physician.

*Reappearance of Menstruation.*—If for any reason the woman does not suckle her child, the menstrual flow will probably return within eight weeks after labor. On the other hand, it is generally believed that the flow ordinarily does not appear as long as the child is suckled, or at least not until it is nearly a year old. More careful observation, however, has shown that such a belief is erroneous, and that a considerable proportion of women menstruate during lactation, and usually without ill effect upon the children. Thus, Pinard states that from 40 to 73 per cent. of all his patients menstruate within six months after the birth of the child, and that the function becomes reëstablished later in multiparous than in primiparous women. Creutz has arrived at somewhat similar conclusions, and states that of 5,494 patients two-thirds menstruated within six months, and one-sixth within the first two months following delivery.

*Final Examination.*—At the end of the third or the beginning of the fourth week the patient should be subjected to an internal examination, and the condition of the perineum, uterus, and appendages carefully investigated. Not infrequently the uterus will be found displaced, when the introduction of a properly fitting pessary may lead to a prompt cure; whereas if the treatment be deferred until symptoms appear, the condition may not be relieved so readily. In other cases various abnormalities may be noted, which should be treated before the patient is discharged, and occasionally it may be necessary to warn her or her husband that operative procedures will be required in the future. If everything is perfectly normal, it is a great comfort to the patient to be assured of the fact; whereas if any abnormality is noted and the attention of some responsible member of the family be directed to it, the physician may save himself from censure if a subsequent examination be made by someone else.



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## CHAPTER XVII

### THE NEWLY BORN CHILD

In this chapter will be considered only those conditions which are of direct practical interest to the obstetrician, who is referred to the standard works upon pædiatrics for information concerning the general physiology and pathology of the infant.

Normally the newly born child begins to cry almost immediately after its exit from the vulva. This act indicates the establishment of respiration, which is accompanied by important modifications in the circulatory system.

**Circulatory Changes.**—As soon as the lungs begin to function, the blood which is brought by the inferior vena cava to the right auricle no longer passes through the foramen ovale, but makes its way directly into the right ventricle, whence it is carried to the lungs by means of the pulmonary arteries. Coincident with the establishment of the pulmonary circulation, there ensues a marked increase in the pressure in the left auricle. This in turn brings about the closure of the valve of the foramen ovale, which after a few months fuses with the periphery of the opening. At the same time the blood ceases to flow through the ductus Botalli into the aorta, and the canal itself gradually becomes obliterated. According to Strassmann, the primary cause for this change is to be found in the fact that the ductus traverses the wall of the aorta in an oblique direction, so that, as soon as the pressure in the aortic arch is increased, its wall acts as a valve and occludes the distal end.

The circulation through the umbilical arteries ceases a few minutes after birth, pulsation disappearing first at the maternal end of the cord. This is brought about by the contraction of the thick muscular walls, which practically obliterate the lumina of the arteries. It is usually stated that after the establishment of the pulmonary circulation the general arterial pressure is diminished to such an extent that it is insufficient to force the blood through them. The investigations of Ahlfeld have shown that this is not the case, and would rather indicate that the contraction of the arteries is brought about by the stimulation resulting from the cooling of the cord immediately after birth. That this explanation is correct is demonstrated by the fact that the circulation can be reestablished by immersing the child in a warm bath.

This point is of practical importance in view of the fact that occasionally, when the cord has not been ligated sufficiently tightly, secondary hæmorrhage occurs from its foetal end after the child has been placed in

a warm bed. To guard against such an occurrence the cord should be reinspected before the physician leaves the house.

The child passes urine almost immediately after birth, and frequently while in the act of being born. In a considerable number of cases a certain amount of meconium is also discharged. As a result of the cooling of the surface of the child on coming into the world, its temperature becomes reduced by a few degrees, which, however, are promptly regained after it has been bathed and placed in a warm bed. For the first few days of life the temperature is in very unstable equilibrium, and a very slight cause may give rise to a considerable elevation.

**Care of the Umbilical Cord.**—As has already been said, the umbilical cord should not be ligated until it has ceased to pulsate, unless there is some urgent reason to the contrary. Two ligatures of sterilized bobbin should be placed about it and tightly tied, one about 2 centimeters from the surface of the abdomen, and the other about the same distance beyond the first, the cord being then cut between them with a pair of sterile scissors.

Owing to the absence of circulation, what is left of the cord undergoes mummification, and gradually a line of demarcation appears just beyond the skin surface of the abdomen, until in a few days the stump sloughs off, leaving behind a small, granulating wound, which, after healing, forms the umbilicus.

This separation usually takes place within the first week after birth, but it is not unusual for it to require a longer time, and occasionally several weeks may elapse before it occurs. In the very rare instances in which the stump is still adherent at the end of the puerperium, it may become necessary to clip it off with a pair of scissors.

Formerly the care of the cord was considered a very trivial matter, and the midwife, as a rule, would wrap it in a piece of greased or singed linen, after which little or no attention was paid to it. This practice, however, and the total neglect of aseptic precautions frequently resulted in an infection which was transmitted through the umbilical vessels, so that in times past large numbers of children perished from so-called "puerperal fever," as well as from tetanus neonatorum. Even now, when the necessity for proper treatment is generally recognized, umbilical infections are not unknown.

Attention was redirected to such conditions by Eröss in 1891, who stated that a great part of the rises in temperature occurring in young infants is due to umbilical infections. Keller, after studying the vital statistics of Berlin for the years 1904 and 1905, concludes that at least 20 per cent. of all deaths during the first weeks of life are due to this cause.

Usually these umbilical infections indicate gross lack of care, but occasionally they occur in spite of every precaution. Thus, within one week four babies in my service died from general streptococcus peritonitis, which could be traced to an infectious process in the umbilical vessels. This epidemic occurred at a time when especial pains were being taken with the care of the cord, and when not a single case of puerperal infection had been in the ward for weeks, so that the only cause which could be discov-



ered for it was an infected finger in the mother of one of the children. As the umbilical stump in these cases presented no outward sign of infection, the conditions would have escaped detection had the children not been subjected to autopsy. Accordingly, it may be stated as a general rule that, whenever children die without any appreciable cause within two weeks after birth, such an infection should be suspected, and the examination of the intra-abdominal portion of the umbilical vessels will usually show that they are filled with purulent thrombi, in which pyogenic micro-organisms can be demonstrated, and which have given rise either to a general infection or a peritonitis. In view, therefore, of the not inconsiderable danger of infection from this source, strict aseptic precautions should be observed in caring for the cord. The reader is referred to Ploss's work for interesting details concerning its treatment in various countries and by aboriginal peoples.

After making the mother comfortable, the nurse should devote her attention to the child. After being anointed with vaseline or olive oil, it should be thoroughly washed with Castile soap and water, as experience has shown that the vernix caseosa is much more readily removed when some oleaginous substance is first employed. Or, it may be removed by means of cotton pledgets soaked in alboline, and the bath dispensed with. After the bath, the stump of the cord should be thickly sprinkled with powdered boric acid and covered with a pad of sterile absorbent cotton, which should be held in place by narrow adhesive strips. If the child is doing well, this dressing need not be changed for some days unless it becomes moist or soiled. On removing it, the cord will usually be found to have become completely separated, otherwise a similar dressing should be reapplied. I have obtained very satisfactory results with this method of treatment, although in some cases it appears to prolong unduly the separation of the cord. Since 1906, I have employed the alcohol dressings recommended by Budberg. For this purpose the umbilical stump is wrapped in a small piece of sterile gauze soaked in 95 per cent. alcohol, after the excess has been allowed to drain off. Such dressings must be changed at least once a day.

After the cord has sloughed off, the granulating umbilicus should be covered by a sterile dressing, and the child should not receive a full bath until it has completely healed. During this period it should be bathed in the lap of the nurse, care being taken not to contaminate the umbilical dressings.

Dr. W. M. Dabney, while an assistant in my service, performed a series of experiments in the hope of determining the best method of dealing with the cord. He treated several series of cases, respectively, with the following dressings: boric acid, salicylic acid, a mixture of salicylic acid and starch, and a wrapping of silver foil. So far as he could see, it made no difference which method was employed, provided the dressings were sterile. In still another series of cases he applied an occlusive dressing of liquid celloidin and absorbent cotton, but found that under such circumstances the cord was kept unduly moist, and separation was perceptibly delayed.

This question has given rise to a great deal of discussion. Dickinson in 1899 read a paper entitled, *Is the Sloughing Process at the Child's Navel Consistent with Asepsis in Child-bed?* and answered the question in the negative. As the result of his observations, he recommended that the cord be completely excised where it joints the abdomen, its vessels ligated, and the wound closed by sutures. Possibly this may prove to be the ideal method of treatment in hospital practice, but it is a question whether it is advisable in private practice, as it is probable that, should the child die within a few weeks after such a procedure, the physician would be severely criticized by members of the family who have become accustomed to the time-honored treatment.

Martin recommended that the cord be ligated close to the abdomen and cut through with a pair of red-hot scissors. Porak and others advocate compression of the cord by powerful forceps, as in angiotripsy. But to my mind these procedures offer no advantages over those already in use; the important point in the treatment being not so much the method employed as the avoidance of infection by the most rigid adherence to the principles of asepsis.

**Care of the Eyes.**—In view of the frequency with which the eyes of the newly born child become infected when passing through the birth canal of women suffering from gonorrhœa, Credé introduced the practice of instilling into each eye immediately after birth one drop of a 1-per-cent. solution of nitrate of silver, which was afterward washed out with salt solution. This procedure has led to a marked decrease in the frequency of gonorrhœal ophthalmia and the cases of blindness resulting from it, and should be followed as a matter of routine. Even in my private work I habitually employ Credé's method, as the development of ophthalmia in several babies treated with boric acid solution taught me that gonorrhœa may be present where least expected.

The prophylactic value of silver nitrate was strikingly demonstrated by Haab, whose statistics showed that its employment in hospital practice reduced the frequency of ophthalmia neonatorum from 9 to 1 per cent., while the statistics from many hospitals show an incidence of only  $\frac{1}{5}$  to  $\frac{1}{10}$  of 1 per cent. If, however, the disease should appear in spite of the precautions taken, it should be promptly and vigorously treated, inasmuch as when neglected it almost invariably leads to clouding of the cornea and often to complete blindness. Cohn estimated in 1876 that 30 per cent. of the patients in the blind asylums of Germany, Austria, Holland, and Switzerland owed their trouble to ophthalmia neonatorum, while twenty years later these figures had become reduced to 19 per cent. Dr. J. J. Carroll, of this city, stated that 30 per cent. of the inmates of the Maryland School for the Blind in 1909 traced their blindness to the same cause, and that its incidence had increased rather than decreased during the previous twenty years. This means that the average practitioner and midwife have failed to appreciate the prophylactic value of Credé's method, and makes pertinent the inquiry as to the advisability of legislating with a view to making the use of silver nitrate compulsory in all cases.

In very rare instances the process may be thoroughly developed at the



time of birth—the so-called intrauterine ophthalmia. In such cases the infection developed while the child was still *in utero*, and Stephenson states that it may even occur without premature rupture of the membranes, having been noted in children born in a “caul.”

Zweifel in 1900 advocated substituting a 1-per-cent. solution of silver acetate for the nitrate, and reports that, in a series of 5,222 children so treated, ophthalmia was observed in only 0.23 of 1 per cent., and that not a single case ended in blindness. The employment of protargol, argyrol, sophol, and various other preparations of silver has been suggested, but experience has shown that they give no better, if as good, results as silver nitrate.

**Stools and Urine.**—For the first few days after birth the intestinal contents are represented by a brownish or brownish-green, soft material—the meconium. It is made up of cast-off epithelial cells from various portions of the intestinal tract, a few epidermal cells and lanugo hairs which have been swallowed with the amniotic fluid. Its peculiar color is due to the presence of bile pigments. During pregnancy and for a few hours after birth the intestinal contents are sterile, but bacteria soon gain access to them and are afterward present throughout life.

After the third or fourth day, with the establishment of the mammary secretion, the meconium disappears, and its place is taken by feces, which are light yellow in color, homogeneous in consistence, and possess a characteristic odor. For the first few days the stools are not formed, but after a short time they take on the characteristic cylindrical shape. The bowels, as a rule, move twice daily, but a single large defecation is sufficient.

The physician should make it a rule to inspect the stools at each visit, and instruct the nurse to save a napkin in anticipation of his arrival, as in this way important information may be gained concerning the digestion of the child.

The child usually urinates almost immediately after birth, and continues to do so at frequent intervals for the first few months of its life. The physician should impress upon mother and nurse the necessity of attempting to train the child to regular habits as to urination and defecation, and it is surprising how soon these may be formed if proper care is taken. For this purpose the napkins should be changed before each feeding, and after the first few weeks the child should be held over a small chamber at these times. It should also be encouraged to defecate at regular intervals. To accomplish this, it should be laid upon the bed at the same hour each day with a napkin under its buttocks, and its abdomen should be stroked along the course of the colon.

**Icterus.**—Not infrequently on the third or fourth day after birth, the skin and conjunctivæ of the child take on a yellowish hue, which may vary from a hardly visible discoloration to an intense jaundice. Kehrer concluded that icterus occurred in 75 per cent. of all children, and, although this estimate is probably too high, there is no doubt that it is very common. According to Hofmeier, the condition is hæmatogenous in origin, and is due to the breaking down of large numbers of red corpuscles

soon after birth. Ordinarily it possesses no clinical significance, and passes off in a few days without treatment.

**Initial Loss of Weight.**—Owing to the fact that the child receives little or no nutriment, and at the same time casts off considerable quantities of urine, feces, and sweat, it progressively loses weight for the first three or four days of its life, the total loss usually aggregating 250 grams (8 ounces). If the child is nourished properly, this is usually regained by the end of the tenth day, after which the weight should increase steadily at the rate of about 25 grams (6 drams) a day for the first few months, so that it becomes doubled by the time the child is five months of age.

The initial loss is usually much greater when the child is excessively large, as well as in premature infants and those who receive an insufficient supply of food.

**Anatomy of the Breasts and Lactation.**—Each breast is made up of from 15 to 24 lobes, which are arranged more or less radially, and separated from one another by a varying amount of fat, to which the size and shape of the organ is in great part due. Each lobe consists of several lobules, which in turn are made up of large numbers of acini. These last are composed of a single layer of epithelium, beneath which is a small amount of connective tissue richly supplied with capillaries. Every lobule is provided with a small duct, which, meeting others, unites to form a single larger canal for each lobe. These so-called *lactiferous ducts* make their way to the nipple and open separately upon its surface, where they may be distinguished as minute isolated orifices.

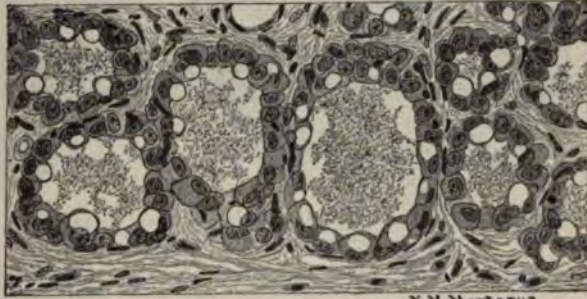


FIG. 323.—LACTATING BREAST (Zeiss, DD-4).

The acini represent the functioning portion of the breasts, and it is from their epithelium that the various constituents of the milk are formed. This fact was first demonstrated by Heidenhain.

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We have already referred to the changes occurring in the breasts during pregnancy, and their condition remains much the same for the first two days after labor. At this time they do not contain milk, but a small amount of *colostrum* can be expressed from the nipples. This is a thin, yellowish fluid, which owes its color to the presence of a pigment which is soluble in ether and, according to Kühne, is analogous to the coloring matter contained in the cells of the corpus luteum.

When examined under the microscope, colostrum is seen to consist of a fluid in which are suspended numerous round bodies, 0.001 to 0.025 millimeter in diameter—the so-called *colostrum corpuscles*—which represent cast-off epithelial cells which have undergone fatty degeneration. The



fluid portion is a transudate which consists in great part of serum albumin and coagulates on heating. It is generally stated that colostrum contains more fat, sugar, and salts, but less proteid material, than normal milk. It possesses but slightly nutritive properties, and is generally believed to act as a mild cathartic, thus aiding in ridding the bowels of the meconium.

*Milk.*—On the third or fourth day after labor and occasionally on the second, the breasts suddenly become larger, firmer, and more painful. This indicates the establishment of the lacteal secretion, and on pressure a small amount of bluish-white fluid—the *milk*—will exude from the nip-

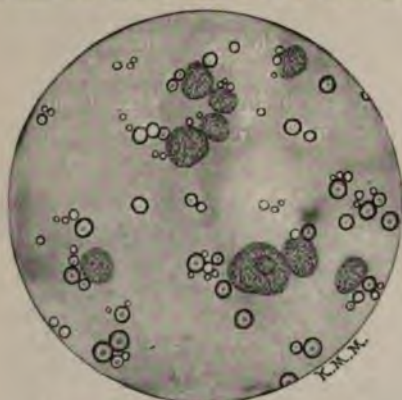


FIG. 324.—HUMAN COLOSTRUM  
(Zeiss, DD-4).



FIG. 325.—HUMAN MILK (Zeiss, DD-4).

ples. Coincident with these changes, the patient experiences more or less lassitude, and may suffer from headache. At the same time she has throbbing pains in the breasts, which may extend into the axillæ, and the pulse becomes slightly accelerated. There is rarely any elevation of temperature. It was formerly believed that the establishment of the milk flow was associated with marked constitutional disturbances, which were regarded as manifestations of the so-called milk fever. As has already been said, a rise in temperature from this cause is very exceptional, and usually is indicative of infection.

Mother's milk is usually bluish-white in color, though it sometimes has a yellowish tinge. It is slightly alkaline in reaction, and has a specific gravity of from 1.028 to 1.034. Under the microscope it appears as a clear fluid in which are suspended large numbers of small round bodies, 0.008 millimeter in diameter—the so-called *milk corpuscles*. These consist of minute drops of fat surrounded by a membrane. Chemical examination shows that they are made up of the triglycerides of olein, palmitin, and stearin. The fluid portion of the milk is a transudate, and consists of protein material, milk sugar, salts, and water. Milk, therefore, represents an emulsion of fine fat droplets in a fluid medium.

The protein material in milk serum consists of casein or caseinogen, which is a direct metabolic product of the mammary epithelium, and differs from serum albumin in that it does not coagulate on heating. The

fat and lactose, or milk sugar, are also products of the epithelial cells. The milk serum contains a considerable amount of mineral matter, which, according to the investigations of Rotch, consists principally of calcium phosphate, 28.87 per cent., potassium carbonate, 23.47 per cent., sodium chloride, 21.77 per cent., potassium chloride, 12.05 per cent., potassium sulphate, 8.33 per cent., magnesium carbonate, 3.97 per cent., and minute quantities of several other salts.

The average composition of milk is as follows: Proteids, 1 to 2 per cent.; fats, 3 to 4 per cent.; sugar, 6 to 7 per cent.; salts, 0.1 to 0.2 per cent., the rest being water. Milk also contains a not inconsiderable number of bacteria, which, according to the researches of Köstlin, are derived from the terminal ends of the lactiferous ducts and the surface of the nipples; it is questionable whether they are present in the deeper portions of the breast.

Nutritious mother's milk varies markedly in its composition, not only in different individuals, but also in the same individual at various times. It is not unusual to find that the milk of one woman, which agrees perfectly with her own child, will prove indigestible when given to the healthy child of another woman. The variation in the composition of the milk of the same woman at different times is dependent upon various factors, principally the diet, the amount of exercise, and the mental condition. The quantity of milk varies to a large extent with the amount of fluid ingested by the patient, and a diet rich in cow's milk conduces to increased mammary activity.

There are large numbers of preparations in the market which are known as *galactagogues*, and are vaunted as increasing the amount of milk; but whatever virtue they may possess is due in great part to the quantity of fluid taken with them. Exercise in the open air also increases the milk flow, and it is frequently observed that a woman who has but a small quantity, so long as she is confined to her room, will secrete an abundant supply as soon as she begins to take outdoor exercise.

The quality of the milk is likewise dependent in great part upon the food and the amount of exercise taken by the mother. It is a matter of experience that a diet rich in proteids increases the ratio of the fats, while excessive exercise diminishes the amount of protein material. Marked alterations in the quality and quantity of the milk not infrequently result from nervous and mental influences, and it is not unusual for some profound emotion to lead to almost complete suppression of the lacteal secretion, or to so change its quality as to render it unfit for the use of the infant. Certain drugs also exert a marked influence upon the milk flow, and it is well known that the use of belladonna or atropine markedly diminishes it. Many substances ingested by the mother may be transmitted through the milk, and thus exert their physiological influence upon the child. This is particularly true of the various cathartics and alcoholic liquors.

It is generally believed that the occurrence of menstruation, or the onset of another pregnancy during lactation, exerts a very deleterious effect upon the quality of the milk, in some cases rendering it necessary



to wean the child. When it is remembered how large a proportion of women menstruate while suckling, and how often the first indication of the occurrence of pregnancy in a nursing mother consists in the perception of foetal movements, it is apparent that the deleterious effect of such occurrences is greatly overestimated.

**Nursing.**—The ideal food for the newly born child is the milk of its mother, and, unless lactation be contraindicated by some physical defect, it is the physician's duty to insist that every woman should at least attempt to suckle her child. In many instances where the supply of milk at first appears insufficient, it becomes increased in amount if suckling be persisted in. The act itself also exerts a beneficial influence upon the involution of the uterus, as it is well known that the repeated irritation of the nipples results in reflex stimulation of the uterus, and Temesvary has proved by actual measurement that it becomes smaller much more rapidly in nursing women. This fact should be urged upon women who are unwilling to nurse their children, and it frequently happens that, although they may have commenced it from selfish motives, they will continue it as long as is necessary.

Unless it be otherwise arranged, the physician who conducts the labor should hold himself responsible for the well-being of the child during the first few weeks of its life, and should not limit his attentions to the mother. He should accordingly give minute directions as to the way in which it should be fed, and see that they are accurately carried out.

*Frequency of Feeding.*—As the nutritive properties of colostrum are very limited, the child should be put to the breast only three times a day until the milk flow becomes established, but after that time it should be fed at frequent and regular intervals. Definite hours should be set for each feeding, and, if necessary, the child should be awakened from a sound sleep at stated times to take its nourishment, for only by this means can its habits be made regular. I do not consider that a nurse has fulfilled her whole duty unless she leaves the patient with a child properly trained in the matter of taking its food.

A definite hour should be arranged for the child's bath, which should be taken as a starting-point in arranging the schedule for feeding. Ordinarily the most convenient time is between 9 and 10 a. m. If the former hour be chosen, the first feeding should be at 7 a. m., and the next immediately after the bath; while if the latter be chosen the child should be fed at 6 and 8 a. m., and again shortly after ten. After the feeding immediately following the bath the baby should be allowed to sleep as long as it will, which will usually be about three hours, after which it should be given nourishment at intervals of two hours until bedtime. By this arrangement it will receive eight or nine feedings during the twenty-four hours. The last should be timed for the usual bedtime of the parents, and only one feeding should be given during the night—that is, between 11 p. m. and 6 or 7 a. m.—and frequently the child can be trained to sleep the entire night without awakening. This, however, can only be accomplished by feeding it at regular intervals during the day, so as to insure that it receives the proper amount of nutriment in the twenty-four hours.



Just before each feeding the napkin should be changed and the child encouraged to urinate, but as soon as it is taken from the breast it should be placed in bed and not disturbed. It should not be allowed to sleep at its mother's breast, nor should it be rocked or fondled after feeding. If these regulations be persisted in, the child will usually go to sleep within a few minutes after being put to bed, and if it wakes before the next feeding is due it will remain quiet. The importance of following these directions cannot be overestimated, for it is only by rigid adherence to such details that the child can be given regular habits, and its care prevented from becoming a strain upon all concerned.

After the fourth or fifth week, one of the breast feedings should be replaced by a bottle, no matter how much milk the mother may have. By so doing the tedium of nursing is greatly reduced, and many a woman is willing to suckle a child which she would otherwise wean. When a mother is obliged to return home every two or three hours to nurse her child, it is apparent that her time is so broken in upon as to render it impossible for her to obtain any real relaxation; whereas if a single bottle be interpolated between any two feedings a free space of four to six hours will be afforded.

*Duration of Feeding.*—Definite rules cannot be given concerning the proper length of each feeding, as this point is dependent upon several factors—the quantity of milk, the readiness with which it can be obtained from the breast, and the avidity with which the child nurses. Generally speaking, it is advisable to allow the child to remain at the breast for ten minutes at first, and to lengthen or decrease the time according to circumstances, three or four minutes being sufficient for some children, while fifteen or twenty minutes will be required by others. There is so universal a tendency toward overfeeding that at first it is better to err in giving too little rather than too much milk. Crying is not always a symptom of hunger, but much more frequently indicates indigestion, resulting from an overloaded stomach. A child which is receiving the proper amount of nourishment should not spit up its food, should increase steadily in weight, and should have normal yellow homogeneous passages. The occurrence of regurgitation, or the presence of curds in the stools, is a sure sign that it is being nursed too long. On the other hand, loss of weight, associated with normal stools and the absence of regurgitation, indicates insufficient feeding.

The child should be weighed twice a week, upon a fairly accurate pair of scales, and its actions inspected daily by the physician. As has already been said, it should regain its birth weight by the end of the tenth day, and from then on it should gain regularly 25 grams a day, or, roughly speaking, 5 ounces a week. After the first few months the increase is more gradual, the average child doubling its weight at the fifth and trebling it at the fifteenth month.

*Care of the Breasts.*—Before and after each feeding the nipples should be carefully washed with a boric acid solution, so as to avoid the possibility of bacteria being ground into them during the nursing. In many cases, particularly if preliminary precautions have not been taken to harden



them, the nipples become very sore during the first few days of nursing, and little cracks or fissures appear upon them. These are extremely painful to the mother, and in some cases render the act of nursing agonizing. In addition to the suffering which they cause, they are also a source of considerable danger, as it is through them that bacteria usually gain access to the interior of the breast. The nurse should therefore be instructed to be on the lookout for them, and to notify the physician of their appearance, as prompt treatment will usually lead to their speedy cure. On the other hand, neglect of these premonitory signs is not infrequently followed by a mammary abscess, for the occurrence of which the physician and nurse are usually more or less justly blamed.

The fact that large numbers of remedies are recommended for the cure of fissured nipples is abundant evidence that they are not always readily relieved. They are best treated by rest, and if the infant could be kept from the breast for twenty-four hours they would heal without further treatment. As this is out of the question, some other means of securing rest must be adopted, and this is best attained by the use of a so-called English nipple shield, or one of the curved variety devised by Slemmons. Many women claim that they are unable to use such a contrivance, but the difficulty is usually due to the fact that the holes in the rubber nipple are too small, and if they are enlarged by passing a red-hot hairpin through them a quantity of milk sufficient for the child can usually be obtained without much difficulty. The application of compound tincture of benzoin to the fissures tends to hasten the healing, and in the intervals between the feedings the nipples should be covered by compresses soaked with boric acid solution. Particular attention should be devoted to the care of the shield, which should be carefully washed after each feeding and kept in a vessel containing a saturated solution of boric acid.

In rare cases the nipples may be so depressed below the surface of the breast as to render nursing out of the question. Here it is useless to attempt it, and steps should be promptly taken to arrest the mammary secretion.

The child's mouth should be scrupulously cleansed before each feeding. This is best accomplished by washing it out with a clean piece of linen dipped in boric acid solution. The investigations of Kneise, which have shown that bacteria are present in the buccal cavity of 98 per cent. of newly born children, and that streptococci and staphylococci are frequently observed, emphasize the necessity for care in this direction.

When the child dies, or if for any reason the physician feels that lactation is contraindicated, steps should be taken to check lactation, or, as it is usually designated, "to dry up the breasts." Formerly this was accomplished by a tedious and laborious process, which consisted in tightly bandaging the breasts, after having covered them with belladonna ointment. Within a few hours they became very engorged and painful, when the excess of milk was drawn off by means of a breast pump, after which the bandage was reapplied, and the process repeated as frequently as necessary, days or weeks often elapsing before the secretion was checked. The treatment was sometimes so painful that the patient complained that it was far worse than the labor itself.

Some years ago, Dr. E. R. Lewis, of Westerly, R. I., told me that equally good results could be obtained in far less time merely by the administration of 20 grains of potassium acetate every four hours. My investigations, however, have shown that the drug is without effect, and that Nature will take care of the entire process, if not aggravated by improper treatment.

Since January, 1905, my practice has been to leave the breasts absolutely alone. Within twenty-four hours after the last nursing, or on the third day if the child has not been suckled, the breasts become greatly engorged, and sometimes quite painful. But if they are not touched, the swelling soon subsides, and the pain disappears within a few hours, after which the breasts gradually become smaller, and contain less and less milk, so that the entire process is over by the end of the third day. If the patient is nervous a placebo may be administered, or if the pain is severe a single hypodermic injection of morphia may be required, but further medication is not necessary. When the breasts are large and pendulous, they may be supported by a bandage, which, however, should not be sufficiently tight to exert pressure. It would accordingly appear that the methods formerly in vogue, and particularly the use of the breast pump, defeated the very purpose for which they were employed, and really served to stimulate the secretion of milk and subjected the patient to great discomfort.

My experience with the method, both in hospital and private practice, has been so satisfactory that I can strongly recommend its general adoption. In cases so treated there have been no mammary abscesses, while the breast pump is no longer employed. Those who are interested in details of the subject are referred to the article of my former assistant, Henry J. Storrs.

**Artificial Feeding.**—When the supply of mother's milk is defective, or when abnormalities of the nipples or constitutional diseases render nursing inadvisable, artificial feeding must be resorted to. Numerous so-called infant foods are advertised for this purpose, but most of them are very defective, so that for practical purposes *cow's milk* in some form is the only available substitute for the mother's milk. Unfortunately, however, it differs markedly from the latter in composition, and under the most favorable circumstances is only an imperfect substitute for it. It is usually slightly acid in reaction, and has a specific gravity of 1.029 to 1.033. Its average composition is: proteids, 4 per cent.; fats, 4 per cent.; sugar, 4.5 per cent., and salts, 0.7 per cent. It is apparent, therefore, that it contains less fat and sugar, and more protein material and salts, than mother's milk, and consequently cannot be used in its natural form, but must first be modified in some way.

If the child is healthy, satisfactory results are frequently obtained by diluting cow's milk with various proportions of water and adding sugar. Such preparations contain approximately the normal amount of proteid material and sugar, but are lacking in fat. In hot weather the mixture should be sterilized, but in cool weather this procedure is unnecessary.



*Modified milk*, in which the various constituents of cow's milk can be altered at will, so that theoretically, at least, it closely approximates mother's milk in composition, promised to supply us with an ideal artificial food, and in many respects is the best substitute for breast milk. But at the same time it differs from it in the fact that its protein material is far less digestible, and, when coagulated by the gastric juice, forms a thick, dense coagulum, contrasting unfavorably with the fine curd formed from human milk. In employing it, therefore, smaller quantities of proteid must be prescribed than are normally present in breast milk.

The space at our disposal is too limited to permit consideration of the many and complicated problems connected with artificial feeding, and the reader is referred to the various treatises upon Pædiatrics for extended information. There are, nevertheless, two points upon which I must insist—namely, the capacity of the stomach and the necessity for training the child to regular habits, no matter what method of feeding is employed. It should be remembered that the stomach of the newly born child is very small, and that one ounce will fill it to repletion. That amount of fluid, therefore, should not be exceeded for the first few days, after which it should be increased very gradually. The instructions as to the frequency and manner of feeding, which have already been given, apply equally well whether the child is fed at the breast or from the bottle, and too great stress cannot be laid upon their rigid observance.

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## CHAPTER XVIII

### MULTIPLE PREGNANCY

The uterus occasionally contains two or more embryos; thus, according to the number present, we have a twin, triplet, quadruplet, quintuplet, or sextuplet pregnancy.

According to Badouin, only five credible instances of sextuplet pregnancy have been recorded, and even several of them have been subjected to considerable criticism. On the whole, it may be said that reports of the birth of a greater number of children at a single labor are to be regarded as apocryphal, although many such are to be found in the older literature, the most remarkable being the Rhine legend, according to which the Countess Hagenau was delivered of 365 embryos at a single labor—manifestly an hydatidiform mole.

**Frequency.**—Wappæus found that more than one child was born in 1.17 per cent. of 20,000,000 cases of labor which he analyzed. The statistics of G. Veit, which were based upon 13,000,000 cases occurring in Prussia, showed that twins occurred once in 89, triplets once in 7,910, and quadruplets once in 371,125 labors. According to Mirabeau, triplets occur more frequently—once in 6,500 cases. De Blécourt and Nijhoff, in 1904, reported a case of quintuplets, and stated that they found in the literature what appeared to be authentic histories of 28 additional cases.

It would appear that multiple pregnancy is more common in cold than in warm climates. This statement is borne out by the statistics of Bertillon and Mirabeau, the latter stating that they occur once in 41.8 labors in Russia, as compared with once in 113.6 labors in Spain. Gache found that they occur most frequently in Greece and least so in Peru, being noted once in 50 labors in the former as compared to once in 170 in the latter country. According to Duncan, twin pregnancy is noted most frequently in multiparæ, especially between the twenty-fifth and twenty-ninth years.

It has been estimated that in 64 per cent. of the cases only one, and in 36 per cent. both sexes are represented. Thus Pinard, in 150 observations, found that both children were males in 46, both females in 46, and of different sexes in 58 cases.

**Ætiology.**—Certain individuals appear to be predisposed toward multiple pregnancy, since it is not unusual for the same woman to give birth to twins or triplets upon several occasions. Thus Puech, upon analyzing 1,262 cases of twin pregnancy, found that 48 of the mothers had had twins twice, 3 thrice, and 1 upon 4 occasions. In some instances, multiple pregnancy has been known to occur in all the females of a family throughout

several generations. Mirabeau has pointed out that an hereditary tendency toward triplet pregnancies was recorded in 13 out of the 75 cases collected by him. This was particularly marked in one family, in which triplets, not to mention twins, had occurred one or more times in five successive generations.

In rare instances, however, this tendency appears to come through the father, and reference is frequently made to the somewhat apocryphal case of the Russian peasant, Wasilef, who is reported to have had 87 children by 2 wives, the first having had 4 quadruplet, 7 triplet, and 16 twin pregnancies; and the second 2 triplet and 6 twin pregnancies.

According to Hellin, Patellani, and Larger, multiple pregnancy should be regarded as a sign of atavistic reversion. The first-mentioned authority states that the ovaries of women who have had a number of multiple pregnancies contain an excessive quantity of ova, but that individual ova with double nuclei are very rarely noted. According to this view, the condition is probably due to the maturation each month of several ova, instead of one, as is generally the rule.

Twin pregnancy may result either from the fertilization of two separate ova or of a single ovum, the first giving rise to *double*, and the second to *single-ovum twins*. In the former case the ova may come from the same ovary, or one from each ovary; while in rare instances both may originate in a single follicle.

Formerly it was generally believed that single-ovum twins were derived from the fertilization of an ovum which presented two distinct germinal vesicles. The existence of such ova is indisputable, Franqué, Herff, Klein, and others having reported undoubted examples of such a condition, while Fig. 326 represents an example of this character found in one of my specimens. When, however, one considers that, in order for single-ovum twins to be developed from such an ovum, each half of the cell must undergo typical maturation and cast off polar bodies, and moreover that each female pronucleus so resulting must be fertilized by a separate spermatozoon, it becomes apparent that the process is not so simple, as might appear at first sight.

Accordingly, in recent years the trend of authority inclines to the view that this class of twins may be produced in several ways: by the fertilization of polar bodies, as believed by Bonnet; by the premature separation of one or more blastomeres from the segmenting ovum; by the cleavage of the embryonic area, or by double gastrulazation of the blastodermic vesicle. In view of the remarkable results obtained in experimental embryology, Sobotta holds that there is convincing evidence in favor of one or several of the latter possibilities. In this event double-ovum twins are closely related to the double monsters, and one may readily follow all gradations from the former to the Siamese twins, and from the latter



FIG. 326.—OVUM WITH DOUBLE GERMINAL VESICLE.



through the double-bodied, double-headed, or double-legged monsters downward to the monsters by inclusion, and finally to the teratomata. Thus, it may well be held that double-ovum twins, on the one hand, and teratomata on the other represent respectively the most perfect and the most rudimentary stages of the same process.

Saniter states that in triplet pregnancy the children are usually derived from two ova—one from one, and two from the other—while in rare cases, one of which he has studied personally, all three children were derived from a single ovum. In the quintuplet pregnancy described by De

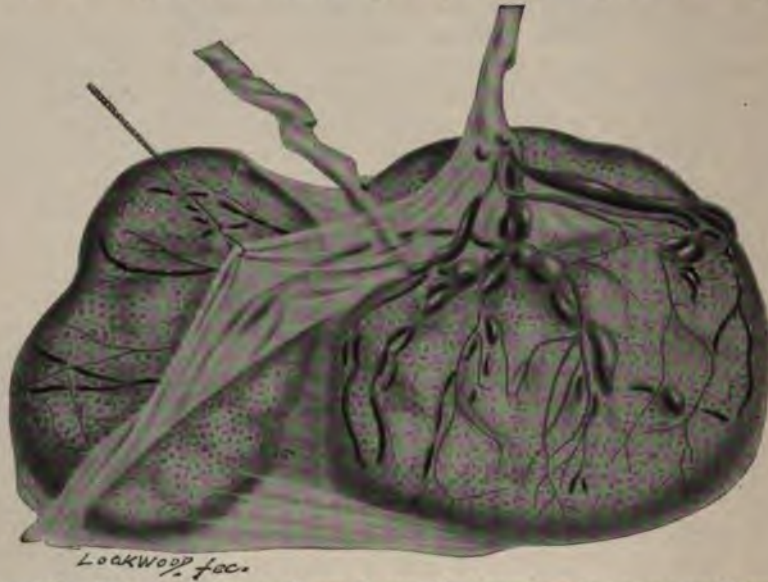


FIG. 327.—PLACENTA, DOUBLE-OVUM TWINS, VELAMENTOUS INSERTION OF CORD.

Blécourt and Nijhoff, three of the children were connected with a single placenta, while each of the other two had separate placentæ; thus indicating that only three ova had been fertilized, one giving rise to triplets, and the other two to single children.

Of 1,159 instances of twin pregnancy analyzed by Ahlfeld, 979 were derived from two ova and 180 from a single ovum; whereas Prinzing in 1,887 cases found that the incidence of uniovular twin pregnancy was 26.3 per cent. In the former case the children may or may not be of the same sex, while in the latter they are always of the same sex, and often closely resemble one another.

**Relation of Placentæ and Membranes.**—The development of one child in either horn of a bicornuate uterus, or of one twin in the uterus and the other in a Fallopian tube, affords indubitable evidence of their origin from two ova; while in ordinary uterine twin pregnancy, the examination of the placenta and foetal membranes after labor usually enables one to determine the mode of origin of the twins. When they are derived from a single ovum, there is a single large placenta from which the two umbilical

cords come off; but, when they are developed from two ova, there are usually two separate placentæ, although occasionally, when these were originally inserted near one another, their contiguous edges may fuse together, thus giving rise to an apparently single large placenta, in which, however, there is no connection between the circulation of the two twins.

In double-ovum twins, no matter whether the placentæ are separate or fused together, there are always two chorions and two amnions, each child being enveloped in its own membranes. Single-ovum twins possess only a single chorion, but, as a rule, two amnions, for the reason that the former represents the wall of the original blastodermic vesicle, while the amnion is more directly connected with the embryo itself. In rare instances a single amnion is found. This condition, which was noted in 44 cases collected from the literature by Holzapfel, is not primary, but results from perforation of the partition wall between the two original amniotic cavities.

This arrangement of the membranes was known to Viardel in the seventeenth century, who stated that when the children were of the same sex they were usually inclosed in a single amnion; whereas twins of different sexes were separated by a partition wall. He expressed the belief that Providence took this means of guarding their morals *in utero*. Saniter (1901), in a very interesting article, has carefully studied the relation of the foetal membranes in triplet pregnancy.

In single-ovum twins there is always a certain area of the placenta in which there is anastomosis between the two vascular systems, which is never present in the fused placenta of double-ovum twins. This condition has been exhaustively studied by Schatz, and occasionally leads to serious consequences. Thus, if at an early period the heart of one embryo is considerably stronger than that of the other, a gradually increasing area of the communicating portion of the placenta is monopolized by the former, so that its heart increases rapidly in size, while that of the latter receives less and less blood and eventually atrophies. Herein is to be found the ex-



FIG. 328.—DIAGRAM SHOWING RELATION OF PLACENTA AND MEMBRANES IN DOUBLE- AND SINGLE-OVUM TWIN PREGNANCY.

a., double-ovum twins; b., double-ovum twins, double membranes, single placenta; c., single-ovum twins, one chorion, two amnions, and one placenta.



planation of the deformity known as *acardia*. In such cases almost the entire placental circulation is utilized by the normal embryo, while the deformed twin receives only enough blood to nourish its lower extremities.



Fig. 329.



Fig. 330.



Fig. 331.

FIGS. 329-331.—DIAGRAMS SHOWING POSITION OF TWINS IN UTERO.

In other instances a difference in the strength of the two hearts leads to the production of hydramnios in the larger ovum. In such cases it is believed that the stronger heart appropriates an ever-increasing share of the blood from the placenta and undergoes hypertrophy, which in turn is followed by a marked hypertrophy of the kidneys, which leads to increased urinary secretion and a consequent excess in the quantity of amniotic fluid.

In the rare instances in which single-ovum twins are inclosed in a common amnion, their umbilical cords may become so twisted about one another as to interfere with the circulation through them, and thus lead to death and an early termination of pregnancy. Sonntag, in 1905, collected 23 such cases from the literature.

Ordinarily in twin pregnancies each ovum occupies, roughly speaking, one-half of the uterus, the long axis being directed vertically. Occasionally, however, they run transversely, so that one foetal sac comes to lie above the other. In such circumstances, the placenta and membranes of the first child must be expelled from the uterus before the second child can be born, unless the latter can make its way past them.

Generally speaking, twins are smaller and weigh less than children resulting from simple pregnancies, although their combined weight is usually greater than that of a single child. The smaller size may be considered normal, but in some instances is partially to be explained by the fact that the excessive distention of the uterus tends to premature labor, so that the twins are often born several weeks before maturity. According to Ribemont-Des-saignes this occurs in 83 per cent. of

primiparæ, and in 75 per cent. of multiparæ.

It is not unusual for twins to differ considerably in size and weight,

especially when derived from a single ovum. Ahlfeld has reported three cases in which the twins weighed, respectively, 2,320 and 1,120, 2,700 and 1,650, and 1,920 and 790 grams.

In double-ovum twin pregnancy one child may die at an early period and be expelled from the uterus soon afterward, while the other may go on to full development. More frequently, however, the dead fœtus is retained until the end of pregnancy, and, being compressed between the uterine wall and the membranes of the living child, becomes flattened out and partially mummified—*fœtus papyraceus* or *compressus* (Fig. 332).

**Superfecundation and Superfœtation.**—The consideration of the difference in the weight of twins, and the possibility of one being aborted while the other develops until full term, leads up to the question of superfecundation and superfœtation. By the former, we understand the fertilization of two ova within a short period of one another, but not at the same coitus; whereas in the latter several months may intervene.

Superfecundation is a well-recognized occurrence in the lower animals, and undoubtedly occurs in human beings, although it is impossible to determine its frequency. It is probable that in many cases the



FIG. 332.—FÆTUS PAPYRÆCEUS (Ribemont-Dessaignes)

two ova are not fertilized at the same coitus, but this can be demonstrated only under exceptional circumstances. It is interesting to note that Dr. John Archer, who was the first physician to receive a medical degree in America, related in 1810 that he had observed a white woman, who had had connection with a white and a colored man respectively within a short period, and was delivered of twins, one of which was white and the other a mulatto. In my clinic a colored woman gave birth to twins, one being born dead and the other perfectly healthy. Distinct evidences of syphilis were present in the first child and its placenta, while the second remained perfectly well some months after its delivery. On questioning the patient, it was ascertained that she had had connection with her husband and another man within a period of a few days, and that the former was under treatment for syphilis at the time.

The occurrence of superfœtation has never yet been clearly demonstrated, though its theoretical possibility must be admitted, as long as the uterine cavity has not become obliterated by the fusion of the decidua vera



and reflexa. As this occurs at the end of the third month of pregnancy, superfetation is out of the question after that time; but prior to that there is no theoretical objection to supposing that, if ovulation should occur, a second ovum might find its way into the uterine cavity and there be fertilized. Still more favorable conditions would be afforded by a uterus duplex.

The French authorities consider that such an event has been conclusively demonstrated, and many of the arguments which have been advanced in its favor are given by Tarnier. On the other hand, most English and German authors are somewhat sceptical, and, while admitting its theoretical possibility, believe that the majority of instances put under this category have been due either to the abortion of one twin or to marked inequality of development.

Cases occasionally occur which at first glance appear to bear out the possibility of superfetation, but, upon closer study, fail to do so. Thus, a physician sent me a specimen which he thought afforded conclusive evidence in favor of such an occurrence. It consisted of two *foetuses*, which had been expelled spontaneously by a healthy multiparous woman, who thought herself four and one-half months pregnant. One *foetus* measured 18, and the other 4 centimeters in length. The former was perfectly fresh, while the latter showed signs of atrophy and had evidently been dead for some time, so that there was but little doubt that each had begun development at about the same period. Even had both *foetuses* been alive, the evidence would not have been unassailable, unless both placentæ presented identical conditions upon examination; as it is conceivable that some lesion might have been present in the placenta corresponding to the smaller child, which would seriously interfere with its growth, without, however, causing its death.

**Diagnosis.**—It often happens that the presence of twins in the uterus is unsuspected during pregnancy, and the first intimation which the physician has of the true condition is afforded by the unusually large size of the uterus after the expulsion of the first child. Despite this fact, however, it may be said that such surprises will rarely occur in the practice of those who take the trouble to make a thorough preliminary examination.

Excessive size of the abdomen during pregnancy frequently causes one to suspect the presence of twins, though usually it will be found to be due to some other condition. Thus, owing to the marked relaxation of the abdominal walls following the birth of the first child, women pregnant for a second time often think that they will give birth to twins, although, as a matter of fact, their fears are generally without foundation.

The diagnostic means at our disposal are palpation, auscultation, and touch. If a multiplicity of small parts is encountered on palpation, the possibility of a twin pregnancy should always be suspected. Positive evidence is afforded by the palpation of two heads, two breeches, and two backs; or at least of one back and four *foetal* poles. The detection of three *foetal* poles is not conclusive, for the reason that in rare instances a subperitoneal or intramural myoma may simulate the head of a child.

Auscultation frequently gives most valuable information, and if one can distinguish two areas, considerably removed from one another, in



which a foetal heart can be heard, twins should be suspected; but a positive diagnosis should not be made unless there is a difference of at least 10 beats per minute in the rate of the two hearts, the sounds being counted for at least a minute in each location.

In rare instances vaginal touch may reveal important findings, as it is sometimes possible to distinguish a macerated head through the intact membranes, or a prolapsed and pulseless cord may be felt through the cervix, while auscultation gives positive evidence of the presence of a living child.

Gauss, in 1910, pointed out that the presence of a second child *in utero* may materially alter the manner of descent of the first through the pelvis. Accordingly, he considers that the existence of a twin pregnancy is indicated whenever vaginal examination shows a head deep in the pelvis in an anterior parietal presentation—that is, with the sagittal suture lying transversely and well posterior to the midline.

The presence of more than two children can be predicted with certainty only under very exceptional and favorable circumstances, although Ribemont-Dessaignes reports the diagnosis of triplets during pregnancy, and its confirmation at the time of labor.

**Course of Labor.**—We have already referred to the abnormal size of the uterus resulting from the presence of twins, which may be still further increased by hydramnios of one ovum. This may give rise to considerable discomfort, the patient suffering markedly from dyspnoea, pressure symptoms, and oedema.

Occasionally the extreme stretching of the uterus may lead to an early dilatation of the cervix. Thus, in one instance, I found the cervical canal completely obliterated and the os externum dilated to 5 centimeters three weeks before the onset of labor. Reference has already been made to the frequency of premature expulsion in these cases; and when labor sets in, owing to the overdistention of the uterus, the pains usually occur at long intervals and are lacking in intensity, so that the birth of the first child is often markedly prolonged. The cord of this child should be cut between double ligatures, as failure to ligate its maternal end may lead to the death of the second child from hæmorrhage, if the twins are derived from a single ovum.

Generally speaking, the membranes of the second child appear at the cervix immediately after the first is born and soon rupture. Its expulsion usually follows the first within half an hour, 75 per cent. of the cases collected by Kleinwächter occurring within this period; while in the remainder a longer time elapsed—as much as twelve hours in 7 of his cases. If spontaneous delivery of the second child does not occur within half an hour, interference is indicated, and the practice formerly in vogue of waiting hours for its spontaneous expulsion cannot be reprehended too strongly.

Changes in position of the second child frequently occur during and just after the birth of the first, so that at this time a renewed examination is necessary in order that any abnormality may be detected and the proper measures taken. The condition of the foetal heart should also be carefully watched, and delivery immediately effected if it becomes abnormal.



As a rule the placenta of the first child remains *in situ* until the completion of labor, but in rare instances it may become partly or completely separated and give rise to hæmorrhage. Under these circumstances the second child should be delivered at once.

In most cases both twins present by the vertex, though not very rarely one descends by the breech. In 1,849 cases analyzed by Leonhardt the following conditions were noted:

| FIRST TWIN. | SECOND TWIN. | PER CENT. |
|-------------|--------------|-----------|
| Vertex,     | Vertex,      | 38.53     |
| Vertex,     | Breech,      | 21.19     |
| Breech,     | Vertex,      | 14.35     |
| Breech,     | Breech,      | 10.76     |
| Vertex,     | Transverse,  | 8.32      |
| Breech,     | Transverse,  | 4.29      |
| Transverse, | Vertex,      | 0.87      |
| Transverse, | Breech,      | 0.77      |
| Transverse, | Transverse,  | 0.92      |
| Total ..... |              | 100.00    |

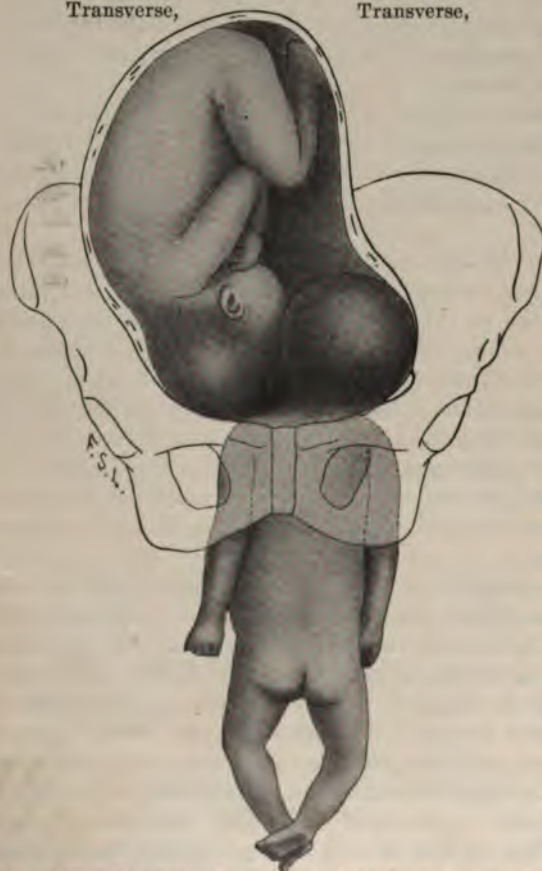


FIG. 333.—DIAGRAM SHOWING COLLISION BETWEEN HEADS OF TWINS.

In rare instances craniotomy upon one child may be indicated.

When the children are small in size, their presenting parts may both attempt to enter the superior strait at the same time, and thus mutually interfere with one another. This complication is known as *collision*, and may occur when both children present by the vertex, or when one presents by the head and the other by the breech. In the first case, an attempt should be made to push up the presenting part which is less distinctly engaged, and then to deliver the other child rapidly. If this is not possible, the whole hand should be introduced into the uterus and the condition of affairs carefully studied. Occasionally it will be found advisable to apply forceps to the uppermost child and attempt to drag it past the other.

Now and again during extraction, when the first child presents by the breech and the second by the vertex, the two heads may become locked just above the superior strait, that of the second fitting into the neck of the first child and making its delivery impossible. Under such circumstances, if the head of the second child cannot be displaced, the first child should be decapitated, as it must inevitably perish during any attempt at extraction; after this the body should be brought away and the second child then delivered by forceps.

In rare instances, the first child may present transversely and be straddled by the second in such a manner that the legs of the latter protrude from the cervix. Traction upon them will serve only to wedge the shoulder of the other child more firmly into the pelvis and give rise to insuperable difficulties. The proper treatment can only be determined after most careful examination under anæsthesia with

the entire hand in the uterus, as the second child cannot be born until the delivery of the first has been effected. The condition may call for version or decapitation, according to the exigencies of the individual case.

Owing to previous overdistention, the uterus not infrequently fails to contract and retract satisfactorily during the third stage of labor, so that abnormalities in the placental period are not infrequent. If there is any tendency toward an excessive loss of blood, the obstetrician should immediately express the placenta by Credé's method, instead of waiting for the fundus to rise up. Occasionally the area of placental attachment may be so large that abnormalities in its detachment may render necessary its manual removal. This operation, however, should not be resorted to unless urgently indicated.

The danger of hæmorrhage does not end with the expulsion of the placenta, as the uterus sometimes relaxes during the hour immediately following. Accordingly, the physician should remain in the house for some time after the completion of labor and give his personal supervision to the condition of the uterus, kneading it upon the first indication of relaxation, and reënforging it by the hypodermic administration of ergot. Neglect in this direction has sometimes led to the death of the patient from post-partum hæmorrhage.



FIG. 334.—DIAGRAM ILLUSTRATING LOCKED TWINS (American Text-Book).



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SECTION V  
*OBSTETRIC SURGERY*

CHAPTER XIX

INDUCTION OF ABORTION AND PREMATURE LABOR—ACCOUCHEMENT  
FORCÉ

**Preparations for Obstetrical Operations.**—Owing to the increased manipulation within the generative tract incident to an obstetrical operation, any lack of cleanliness entails even more risk than in the case of normal labor. Accordingly, the maintenance of a rigid aseptic technique is as absolutely imperative as in major surgical operations.

The hands of the operator and his assistants should be thoroughly



FIG. 335.—SHOWING PATIENT AT EDGE OF THE BED, WITH LEGS HELD IN POSITION BY LEG-HOLDER.

washed and disinfected, as described in Chapter XV, and then encased in sterile rubber gloves. As already indicated, I consider the use of the latter



essential even for the conduct of normal, and consequently no argument need be advanced as to their necessity at operations.

A sufficient quantity of dressings, towels, gauze, absorbent cotton, and ligatures, carefully sterilized beforehand, should be in readiness. All instruments should be rendered sterile by boiling immediately before the operation. As an emollient, vaseline, which has been sterilized by boiling in small jars, will serve every purpose.

The pubic hairs should be shaved, and the external genitalia thor-



FIG. 336.—SHOWING PATIENT COVERED WITH STERILE DRESSINGS PREPARATORY TO OPERATION.

oughly cleansed with green soap and hot water, rinsed off with sterile water, freely irrigated with 95 per cent. alcohol and finally with a 1 to 1,000 bichloride solution, and finally covered with a towel soaked in the same, which should remain in place until the operation is begun. Disinfection with tincture of iodine has not proven satisfactory in my hands, as in some patients it leads to intense irritation, which may persist for some days.

If the woman is uninfected, it is not necessary to attempt to disinfect the vagina by means of antiseptic irrigations or other manipulations. But

if the temperature is elevated, or the patient has been subjected to repeated examinations or attempts at delivery, a vaginal douche of a 1 to 5,000 bichloride solution may be given.

Before the sterile dressings are put in place, the bladder should be emptied with a sterile rubber catheter. In the early months of pregnancy, a distended bladder interferes with bimanual manipulations, while at labor it may affect the engagement of the presenting part, and after the birth of the child interfere with the proper conduct of the third stage of labor.

Obstetrical operations, with the exception of Cesarean section, are usually undertaken with the patient in the lithotomy position. As the ordinary low beds now in use are very inconvenient for the performance of an operation, it is advisable, even in private practice, to place the patient upon a narrow table: one that will answer the purpose quite satisfactorily is usually to be found in every kitchen, but, if a suitable table is not available, a satisfactory makeshift may be obtained by unscrewing the mirror from a bedroom bureau. Anæsthesia is indispensable for all but the simplest operative procedures, and if it is to be prolonged, ether is safer than chloroform, on account of the late poisoning which sometimes follows the use of the latter drug. As soon as the patient is fully under its influence, her buttocks should be brought to the edge of the table, and her legs held in place by a leg-holder. The nightgown should be rolled up above the hips to avoid soiling, and, as soon as the external genitalia have been prepared, the legs should be encased in sterile stockings made especially for this purpose, and the abdomen and buttocks covered with sterile towels in such a manner as to leave only the genitalia exposed. To avoid the possibility of contamination from the rectum, it is advisable to empty the lower bowel by means of an enema, and then cover the anus with a folded sterilized towel, which can be held in place by a strip of adhesive plaster passed over the buttocks, after which a specially prepared sterile sheet should cover everything except the immediate field of operation.

**Induction of Abortion.**—By this term is understood the artificial termination of pregnancy before the foetus has attained viability—namely, prior to the twenty-eighth week. The operation dates from the most remote antiquity, and more or less accurate directions for its performance are to be found in the earliest writings upon medicine. It was so extensively practiced in Rome that we find it repeatedly referred to by Plautus, Juvenal, and other secular writers as a matter of every-day occurrence. With the spread of Christianity, however, it came to be considered as criminal, except when undertaken as a last resort in order to save the life of the mother; and we now draw a sharp distinction between criminal and therapeutic abortion. For full historical details the reader is referred to the works of Levin and Brenning, Brouardel, and Kleinwächter.

**Indications.**—Three groups of cases may offer an indication for the operation. Thus we may think it our duty to induce an abortion: (1) As a direct means of saving the life of the mother; (2) to do away with a condition which may threaten her life if gestation continues; and (3) to avoid certain dangers which may supervene if pregnancy is allowed to progress to full term.



Under no circumstances should an abortion be undertaken, unless a careful and thorough examination has demonstrated that the patient is in a really serious condition. Her statements are entitled to but little weight, and the decision to interfere should be based entirely upon objective symptoms and conditions. Moreover, it should never be done without a consultation with a second physician, who assumes his share of the responsibility. This precaution, besides securing for the patient additional advice, will protect the physician from a possible blackmailing on the part of unscrupulous persons.

In the first group, the best-recognized indication for the operation is afforded by pernicious *vomiting of pregnancy*. In most instances this condition is neurotic in origin and can be cured by appropriate measures, particularly by a modified rest cure, dietetic treatment, and suggestion. More rarely, however, the vomiting is a manifestation of a profound toxæmia, as will be described in the chapter on the toxæmias of pregnancy. If the latter diagnosis be established, and the condition prove refractory to treatment, the prompt induction of abortion is urgently demanded.

Prior to the recognition of the varying nature of this condition, there was a natural hesitancy on the part of the physician to interfere owing to the fact that in most cases the vomiting ceased spontaneously, or was relieved by treatment. For this reason, the operation was frequently postponed until the condition of the patient had become so serious that death was the inevitable consequence, whether abortion was induced or not. Now that we know more about it, such delay is not justifiable.

The induction of abortion is likewise urgently indicated when the uterine contents have become infected, a condition which frequently follows attempts at *criminal abortion*. Under such circumstances, if the fœtus has not already succumbed it will almost certainly die, and the greatest chance of saving the woman's life lies in promptly emptying the uterus and cleaning its cavity.

Formerly it was believed that abortion should be induced for incarceration of the *retroflexed pregnant uterus*, as well as in the rare cases of hernia of that organ, inasmuch as death is the usual result if the patient be left to herself. At present, however, better results are obtained in the former condition by performing laparotomy, freeing the uterus from adhesions and replacing it in a normal position, after which pregnancy may pursue an uninterrupted course.

In the second group, marked *renal insufficiency* or acute nephritis may necessitate the operation. But inasmuch as such conditions usually develop later in pregnancy, they will be considered when we take up the induction of premature labor.

*Diseases of the ovum*, such as hydatidiform mole, occasionally afford an indication for the operation. Whenever this condition is diagnosticated the uterus should be emptied at once, no matter what be the period of pregnancy, as under such circumstances the fœtus is either dead or very imperfectly developed, and, if the diseased chorion be allowed to remain in the uterus, a chorio-epithelioma may develop.

*Uterine hæmorrhage* in the early months of pregnancy is generally a



sign of beginning spontaneous abortion, but if the loss of blood continues for some time, and is not followed by expulsion of the ovum, the uterus should be emptied artificially. The rare cases of *missed abortion*, in which the ovum is retained for weeks or months after the death of the embryo, demand that the uterus should be emptied as soon as a satisfactory diagnosis is established.

The indications in the third group are afforded by markedly *contracted pelvis* or tumor formations, and pulmonary tuberculosis. Formerly, the induction of abortion at an early period was considered justifiable when the pelvis was so contracted as to present an absolute indication for Cæsarean section; but at present, in view of the excellent results which attend the latter operation, this view is no longer held. The same applies when pregnancy is complicated by the presence of *uterine myomata*. If the symptoms are urgent, hysterectomy should be performed without regard to the existence of pregnancy; but if the tumor promises to act merely as a mechanical obstacle to labor, pregnancy should be allowed to go on to term, and Cæsarean section then performed, followed by removal of the uterus.

*Ovarian tumors* complicating pregnancy do not call for the induction of abortion, but should be removed by laparotomy as soon as the diagnosis is made. In many such cases this can be done without causing interruption of the pregnancy, and spontaneous delivery will occur at term.

The induction of abortion is not indicated in *malignant growths* involving the uterus or adjacent organs. In carcinoma of the cervix, the treatment to be pursued differs according to circumstances. If the condition be operable, immediate hysterectomy is indicated without regard to the presence of pregnancy; but if the disease has progressed too far to offer a prospect of permanent cure after operation, gestation should be allowed to continue in the interests of the child, which should be delivered at term by the procedure most appropriate to the particular case.

Owing to the well-known fact that pulmonary tuberculosis usually progresses much more rapidly after child-bearing, it is advisable that tuberculous women take every precaution to avoid the possibility of conception. If this occurs, however, it is the duty of the physician to induce abortion, in the hope that by ending the pregnancy, and placing the patient in proper surroundings afterward, the disease may be arrested. I feel very strongly that interference is not only justified, but is almost imperative, in a first pregnancy, or in patients in whom the existence of the disease is only discovered after the occurrence of conception. On the other hand, I feel equally strongly that a second abortion should not be done after the patient has been warned to avoid the possibility of becoming pregnant until after the disease has been either cured or at least arrested.

*Methods of Inducing Abortion.*—The methods of inducing abortion vary according to the duration of pregnancy. In the first four months the operation can frequently be completed at a single sitting, if necessary, whereas between this period and the seventh month the methods employed for the induction of premature labor are more appropriate. In the first period, if the cervix is somewhat softened, it can usually be sufficiently dilated by means of Goodell's or Hegar's dilators to admit one finger. The entire hand,



anointed with sterile vaseline, is then introduced into the vagina and the index finger carried up into the uterine cavity; while the other hand, placed upon the abdomen, forces the uterus downward. With the finger within the uterus the placenta is separated from its attachments, after which, according to the duration of pregnancy, the product of conception is removed entire or is broken up into small pieces, which can be removed by means of an abortion or ovum forceps.



FIG. 337.—GOODELL'S DILATOR.

To attempt to empty the uterus blindly by means of a curette and ovum forceps is an unwise procedure, inasmuch as many cases are reported in which such operations have caused perforation. Still more frequently larger or smaller portions of the placenta are left behind in the uterus, giving rise by their presence to serious hæmorrhage and occasionally to infection. In other instances only a portion of the decidua is curetted away, while the ovum is left *in situ* and goes on to further development. Accordingly, one can never feel sure that the operation is complete, unless one or more fingers have been introduced into the uterus and carefully palpated its interior.

In many cases, and particularly in women pregnant for the first time, the cervix may be so resistant that rapid dilatation can be effected only at expense of deep laceration. Under such circumstances, if haste is not imperative, a strip of sterile gauze may be tightly packed into the cervical canal and the vagina firmly tamponed with the same material. When the pack is removed at the end of twenty-four hours, the entire ovum will frequently follow it; while in other cases the cervix will be sufficiently softened to permit the introduction of the finger, or at least of its dilatation with a suitable instrument. The employment of a laminaria tent has been recommended by many authorities, and affords an efficient means of slow dilatation, but, as it cannot be sterilized satisfactorily, its use adds greatly to the risk of infection.



FIG. 338.—OVUM FORCEPS.

On the other hand, when rapid dilatation is out of the question, and it is desired to complete the abortion at one sitting, the uterus may be readily and rapidly emptied after vaginal hysterotomy. In this operation, the bladder is separated from the anterior wall of the cervix, and the latter incised with scissors up beyond the internal os. The finger can then be introduced into the uterine cavity and peel off and remove the ovum, after which the uterine and vaginal wounds are united by catgut sutures. The details of this operation, which I employ with increasing satisfaction and frequency each year, will be found under Vaginal Cæsarean Section.

Abortion is sometimes induced by perforating the membranes with a sterile sound and allowing the liquor amnii to drain off. The desired result, however, does not always follow this manœuvre, and it frequently becomes necessary to supplement it by one of the procedures just described.

In the early months of pregnancy exposure to the action of the Röntgen ray sometimes leads to the death and subsequent extrusion of the fœtus. Reifferscheid, however, states that the method is not applicable to the induction of therapeutic abortion, as repeated exposures are required and even then the result is not assured.

*Prognosis.*—The prognosis varies according to the indication for which the operation is undertaken, but, with the patient in fairly good condition, satisfactory results should always follow, provided a rigid aseptic technique is observed. In my hands vaginal hysterotomy has proved a much more satisfactory and less dangerous procedure than forced instrumental dilatation of a rigid cervix.

**Induction of Premature Labor.**—By this term we designate the artificial termination of pregnancy after the child has reached the period of viability—that is, after the twenty-eighth week. The operation was performed by Guillemeau, Mauriceau, Justine Siegemundin, and others in isolated cases for hæmorrhage, but, according to Denman, it was not generally advocated until 1756, when a conference of physicians was held in London to devise means for doing away with the frightful mortality then following Cæsarean section for contracted pelvis.

*Indications.*—The indications for the operation are twofold: to obviate the dangers attending delivery at term through a contracted pelvis, and to save the life of the mother, when seriously threatened by some disease from which she may be suffering, or on account of some pathological condition existing in the ovum.

In *contracted pelvis*, premature labor is induced with the idea that the imperfectly developed child will be born more readily than at term. This view is undoubtedly correct, and if the welfare of the mother alone were concerned the operation should be undertaken in all cases. We know that labor will be easier the earlier the operation is performed, but it must be remembered that the child will be less liable to survive, and, even if born alive, its chances of succumbing to complications after its birth will be proportionately greater. Inasmuch, then, as the later the operation the better the outlook, so far as the child is concerned, the induction of premature labor should not be attempted before the thirty-fourth, and preferably not before the thirty-sixth, week of pregnancy.

The question as to the propriety of the operation has given rise to an extensive literature. At the International Medical Congress of 1890, held in Berlin, it was one of the chief subjects under discussion, when Säger was practically the only speaker who opposed its employment in moderate degrees of pelvic contraction. With increasing knowledge as to the course of labor in contracted pelvis, together with the generally good results following the classical Cæsarean section, and the development of pubiotomy and extra-peritoneal Cæsarean section, a marked change in sentiment has occurred, and the induction of labor has lost greatly in popularity.

It is now generally recognized that from 70 to 80 per cent. of all labors complicated by contracted pelvis, including the cases of pronounced deformity which require radical interference, will end spontaneously if treated expectantly. With this fact in mind Pinard, Bar, Krönig, myself, and



others hold that the induction of premature labor is no longer justified, and that in cases of moderate pelvic contraction equally good results for the mother, and far better results for the child, will be obtained by abstaining from the former operation, and subjecting the patient to a test of the second stage of labor, and resorting to Cæsarean section or pubiotomy should nature prove herself inefficient.

Following these principles, 829 cases of contracted pelvis of all grades were treated in my clinic up to July, 1910, and 74.76 per cent. of the patients were delivered spontaneously. Three-quarters of the operations were necessary on account of the pelvic contraction, while the remaining quarter were performed for non-pelvic indications. 90.3 per cent. of the children left the clinic in good condition, and upon deducting the cases in which the child was dead at the time of admission of the patient, or died from such extraneous causes as syphilis, broncho-pneumonia, etc., the net foetal mortality due to the pelvic contraction was 4 per cent.

The principal difficulty connected with the induction of labor is to recognize the cases which will require it, and to choose the correct time for its performance, since we are unable to determine accurately the size of the child's head. The methods of Müller, Ahlfeld, and others, to which reference will be made in the chapter upon the treatment of contracted pelvis, do not lead to very accurate results, so that the operation is frequently performed unnecessarily, or, owing to the desire of postponing it until the latest possible moment, it is not undertaken until the child's head has attained such proportions as to render its passage through the pelvis difficult or impossible.

The results obtained are extremely satisfactory so far as the mother is concerned, the maternal mortality being only 1.03 per cent. in 391 operations performed by Ahlfeld, Bar, Leopold, and Pinard. On the other hand, the foetal mortality is relatively high, varying from 45 to 12 per cent., according to the statistics from various lying-in hospitals. Kleinwächter, after an exhaustive study of the subject, concludes that 78.3 per cent. of the children are born alive, but that many of them die soon after birth, and only 60.4 per cent. leave the hospital in good condition. According to these figures, then, the net mortality would be 39.6 per cent.; but when we consider that most careful nursing and appropriate feeding are afterward necessary, it is apparent that no inconsiderable portion of the children dismissed from the hospital in good condition must inevitably perish within the first year, and it is hardly an exaggeration to state that scarcely one half of those born alive survive that period. It would, therefore, appear that the ultimate results, so far as the children are concerned, are so poor as not to commend the operation to favorable consideration, and that equally good results would be obtained by treating all cases expectantly, and performing craniotomy whenever operative delivery became necessary. As this would be a manifest absurdity, it follows that the operation should be abandoned. In my entire experience, I have employed it in only one case of contracted pelvis, and have no cause to regret my action. It must, however, be admitted that all authors do not share this view, as Norris, Herff, and others contend that their results are fairly satisfactory.



At the present time, then, it seems to me that the only rational indication for the induction of premature labor, so far as concerns the existence of disproportion between the size of the head and the pelvis, is afforded by the rare cases in which the pelvis is normal but the child abnormally large, owing either to excessive development or to an undue prolongation of pregnancy. If excessive development be detected some time previously to term, the operation is clearly indicated, and the same holds good in the exceptional cases of prolonged pregnancy, provided the child appears to be fully developed.

The most usual indication for the operation, however, is afforded by diseases which threaten the life of the mother, while at the same time there exists a probability of cure after the termination of gestation. This is particularly true in those cases of *toxæmia* or *acute nephritis* complicating pregnancy, which show no tendency to subside in spite of appropriate treatment. Experience teaches that under such circumstances, even if pregnancy be allowed to continue, premature labor frequently occurs spontaneously, when a large proportion of the children are born dead, or, if alive, very imperfectly developed. Moreover, one should also take into consideration the possibility that the renal changes may become chronic. Accordingly, if threatening symptoms supervene, labor should be induced at any period of pregnancy without too conservative a regard for the life of the child.

In patients presenting toxæmic symptoms, the total amount of albumin and urea contained in the twenty-four hours' urine should be determined daily, and whenever there is a steady increase in the amount of albumin and a corresponding decrease in the amount of urea, in spite of appropriate treatment, labor should be induced in the hope of preventing the onset of eclampsia. If eclampsia supervenes, pregnancy should be terminated as soon as possible by *accouchement forcé*, provided the medical attendant is a competent operator.

*Cardiac lesions* occasionally demand the induction of premature labor, but this should be resorted to only in cases of broken compensation, which do not yield to appropriate treatment.

From the time of D'Outrepont (1828), it has been recommended that the operation be undertaken in the interests of the child in the rare cases of *tuberculosis* in which the condition of the mother is so serious as to make it probable that she will not live until term.

Spontaneous interruption of pregnancy frequently occurs during the course of the acute infectious diseases—pneumonia, typhoid fever, etc.—but, inasmuch as experience has shown that it materially increases the risks to the mother, the induction of premature labor is contra-indicated.

In rare instances a general peripheral *neuritis* may so endanger the life of the mother as to call for interference. Lepage and Sainton (1901) reported a case of alcoholic origin in which the induction of labor was followed by most happy results.

The milder forms of *chorea* complicating pregnancy are usually readily amenable to treatment, but when the disease assumes a grave type it is attended with great danger, the maternal mortality, according to Fehling,



being 36 per cent. Therefore, if the patient appears to be in serious danger, premature delivery should be brought about, as experience has shown that the emptying of the uterus is sometimes followed by marked improvement.

In patients suffering from true *diabetes*, gestation sometimes exerts a very deleterious influence upon the course of the disease. Accordingly, if the patient's condition becomes alarming, labor should be induced. In the majority of cases, however, the so-called diabetes of pregnancy is merely a lactosuria which is not likely to be attended by serious symptoms, the patients being spontaneously delivered of healthy children at term.

According to Graefe and others, the occurrence of pregnancy in patients suffering from *pernicious anæmia* or leukæmia adds markedly to the gravity of the condition, so that in occasional cases the induction of premature labor may be indicated.

In patients suffering from pyelitis, the pregnant uterus may so compress the ureter as to cause a damming back of the purulent discharge, and thus give rise to a *pyelo-nephrosis*. In such circumstances the induction of premature labor is indicated. In several cases under my care interference was followed by surprisingly good results, the patients recovering without further treatment.

Formerly the induction of premature labor was recommended when pregnancy is complicated by *uterine* or *ovarian tumors*, or by malignant disease of the uterus or rectum, which would offer an insuperable obstacle to the birth of a full-term child. At the present day, however, the operation can hardly be considered justifiable. What has already been said in connection with the induction of abortion under similar condition also holds good here.

In *hydramnios*, when the abdomen is so distended as to seriously threaten the life of the patient, pregnancy should be terminated without too much regard for the preservation of the child, as in many cases it is so poorly developed as to have but little chance of living, even if born at full term.

In cases of *hydatidiform mole* alarming symptoms usually come on before the fœtus is viable; but even should the twenty-eighth week be safely passed the immediate termination of pregnancy is imperatively demanded.

Whenever *placenta prævia* is positively diagnosed, the termination of pregnancy is urgently indicated, as it is impossible to predict at what moment uterine contractions may come on and give rise to profuse or even fatal hæmorrhage.

In rare cases of *habitual death of the fœtus* in the later months of pregnancy, when not due to syphilis or renal disease, the induction of premature labor has been recommended at a time slightly anterior to that at which fœtal death has occurred in previous pregnancies, in the hope that a living child may be obtained. In such cases the operation may be undertaken if the parents are extremely anxious for a living child, although in no instance should a positive assurance of success be held out to them.

*Prognosis.*—As far as the mother is concerned, the prognosis of the induction of premature labor is excellent, provided a rigorous aseptic

technique is observed and her physical condition is not critical at the time of the operation.

The prognosis for the child depends, of course, upon the degree of its development, as well as upon the pathological condition for which the operation is undertaken. Generally speaking, in the case of children born before the thirty-second week the chances of surviving are very small, especially when nephritis or hydramnios affords the indication for interference.

*Methods of Inducing Premature Labor.*—The simplest method—that of Scheele—consists in perforating the membranes with a sharp instrument and allowing the amniotic fluid to drain off. The results, however, are uncertain, so that the procedure is applicable only in a very limited number of cases, more especially in hydramnios, and in marginal placenta prævia.

In the method most usually employed—that of Krause—a bougie is introduced between the membranes and the uterine wall. In carrying out this procedure the patient is placed in the dorsal or Sims's position, and the external genitalia carefully disinfected. The cervix is then brought into view by means of a speculum, and one or more sterilized bougies passed through it and gently carried high up into the uterine cavity, between the membranes and the uterine wall. In place of bougies, I prefer thick-walled rubber catheters, 8 to 10 millimeters in diameter, which can be readily sterilized by boiling. They should be introduced by means of a copper stylet, which is withdrawn after the catheter is in place.

The only objection to Krause's method is its uncertainty. In many cases the introduction of a single catheter is followed by uterine contractions within a few hours, which lead to the expulsion of the fœtus after a longer or shorter period. Not infrequently, however, twenty-four hours may elapse without the appearance of pains. In such circumstances a second or third catheter should be introduced. In rare instances even then the desired result is not accomplished, and it becomes necessary to terminate pregnancy in some other manner. But for the general practitioner, when haste is not essential, this is the safest and best method of procedure.

More certain and rapid results are obtained by the use of inflatable rubber balloons. Those of Champetier de Ribes are conical rubber bags with reënforced walls, from whose small end extends a thick rubber tube provided with a stopcock. They are made in several sizes, the largest having a capacity of 400 to 500 cubic centimeters. The patient having been placed in the dorsal or Sims's position, the cervix is brought into view. If its lumen is 1.5 centimeters in diameter the bag can be passed without difficulty, but if smaller it should be dilated up to that size by means of a suitable dilator. The bag, which has been sterilized by boiling, is then tightly rolled into a cylinder, seized with an appropriately shaped forceps, thickly smeared with sterile vaseline, introduced into the lower uterine segment, and then pumped full of sterile salt solution. Within a few hours it usually so irritates the uterus as to induce contractions, which soon lead to dilatation of the cervix and the expulsion of the bag, after which the child can be ex-



tracted or labor allowed to end spontaneously, according to the exigencies of the case. Where greater haste is necessary, the dilatation may be accelerated by attaching a weight to the end of the tube and allowing it to hang over the foot of the bed. This method gives very satisfactory results, though it is evident that the introduction of the large bag into the lower uterine segment must displace the presenting part, and occasionally give rise to malpresentations.

Tarnier's *excitateur utérin*—a thin-walled rubber bag 3 or 4 centimeters

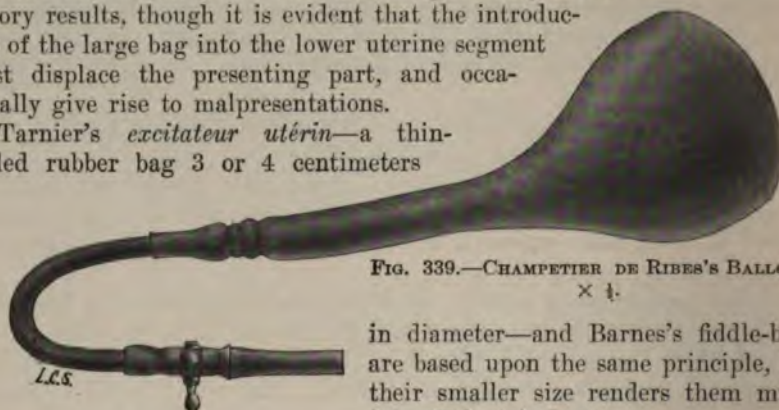


FIG. 339.—CHAMPETIER DE RIBES'S BALLOON.  
× ½.

in diameter—and Barnes's fiddle-bags are based upon the same principle, but their smaller size renders them much less efficient irritants.

When the cervix is but slightly dilated, the use of a sterile tampon may be attended by most excellent results. In such cases, under the most rigid aseptic precautions, the end of a sterilized 4-inch roller gauze bandage is tightly packed into the cervical canal by means of a uterine dressing forceps, after which the vagina is firmly and tightly packed with the same material.



FIG. 340.—CHAMPETIER DE RIBES'S BALLOON READY FOR INTRODUCTION.

The pack should not be allowed to remain in place for more than twelve hours, and on its removal at the expiration of that period the cervix will be found sufficiently dilated to permit of other manœuvres.

Numerous other methods for the induction of premature labor have been suggested from time to time, among which may be mentioned that of Cohen. This consisted in the injection of 200 to 300 cubic centimeters of aqua picis between the uterine wall and the membranes. Other writers have substituted various fluids. Thus, Pelzer suggested the use of 100 cubic centimeters of sterile glycerine, which promptly gives rise to uterine contractions. Its employment, however, is not to be recommended, as it is occasionally followed by serious symptoms of intoxication, hæmoglobinuria, albuminuria, elevation of temperature, cyanosis, and occasionally by death. Pfannenstiël was the first to call attention to these dangers, and his warning has been reinforced by similar experiences in the practice of other writers. Full details respecting the various other methods suggested for the induc-

tion of premature labor will be found in the monographs of Kleinwächter, Fieux, and Williamson.

**Accouchement Forcé.**—By this term is understood the forcible dilatation, or incision, of the intact or partially dilated cervix followed by the immediate delivery of the child. In pre-antiseptic times the operation was so universally followed by infection that it fell into deserved disrepute; but



FIG. 341.—VAGINAL AND CERVICAL PACK IN POSITION.

at the present day it has been rehabilitated, and when properly performed under suitable conditions has been the means of saving many lives. An excellent *résumé* of the history of the operation will be found in the dissertation of Ruhemann. Generally speaking, if the cervix be firm and hard and the canal not obliterated, forcible dilatation is apt to be very difficult and attended with considerable risk to the mother, and its resistance can be better overcome by a cutting operation. On the other hand, when the cervix is soft and its canal practically obliterated, rapid dilatation is readily performed, and is followed by most satisfactory results. As a general rule, it is more difficult in primiparous than in multiparous women.

**Indications.**—In this country the most usual indication for *accouchement forcé* is threatened or actual eclampsia. Occasionally it becomes necessary in concealed or accidental hæmorrhage, or in other conditions which threaten the life of the mother or child, such as acute œdema of the



lungs, or broken cardiac compensation. It should, however, not be employed in placenta prævia.

*Manual Dilatation.*—If labor has already begun, the cervical canal is obliterated, and the resistance offered only by the external os, most excellent results are obtained by the method of manual dilatation suggested by Philander A. Harris. But if labor has not set in, and the cervix is hard and rigid, the operation is both difficult and dangerous; and if the attempt at dilatation be forcibly persisted in, it frequently gives rise to deep tears through the cervix, and occasionally through the lower uterine segment as well, which may lead to the death of the patient from hæmorrhage or in-



FIG. 342.—DIAGRAMS ILLUSTRATING MANUAL DILATATION OF CERVIX (HARRIS).

fection. Generally speaking, unless the cervix is soft and yielding, and its canal at least partially obliterated, delivery should be effected by vaginal hysterotomy.

At the time of operation the patient should be profoundly anesthetized and the aseptic technique most rigorous. The danger of contamination from the feces can be minimized by moving the bowels freely by means of a rectal enema, and then applying over the anus a sterile towel, which is held in place by strips of adhesive plaster until the completion of the various manipulations. One hand, thoroughly anointed with sterile vaseline, is then introduced into the vagina, and the index finger is carried up the cervical canal and through the internal os, and followed as soon as possible by the second finger. When this has been accomplished, completion of the dilatation is usually comparatively easy. The thumb is pushed past the index finger with much the same motion as is employed in snapping one's fingers; then, as dilatation progresses, pass two, three, and finally all four fingers. These manœuvres are clearly shown in Fig. 342.

When the internal os is obliterated, complete dilatation of the cervix can be readily effected by Harris's method, and satisfactory results obtained within half an hour. I employed this method 83 times in the first 5,000

cases delivered in the Johns Hopkins Hospital, and found it very effective, and am able to confirm all that Harris has claimed for it. It should, however, be remembered that it is not devoid of danger, and even in suitable cases may lead to deep cervical tears. From my own experience, its use is contra-indicated in placenta prævia on account of the increased liability to deep cervical tears, and even to rupture of the uterus.

Furthermore, the operator should bear in mind that the liability to cervical tears is greater the more rapidly dilatation is effected, and he should therefore be careful to avoid undue haste. This caution is the more necessary, as there seems to be an irresistible tendency to overestimate the time consumed in the process, and from my own experience I know that what may seem to be a long time to the operator is often in reality only a few minutes. For this reason, it is always well to control such a tendency by watching the clock, as one should judge of the excellence of an obstetrician under such circumstances by the deliberation, rather than by the rapidity, with which he operates.

Edgar and Bonnaire have described bimanual methods of dilatation, which they claim give most satisfactory results. I have not employed them, and therefore cannot express a personal opinion as to their merits. On general principles it may be assumed that they afford somewhat greater opportunity for infection from the rectal contents, since both hands are used and therefore must come into more intimate contact with the anal region than in Harris's method.

*Dilatation by Means of Champetier de Ribes's Balloon.*—Whenever haste is not a great consideration, this is the ideal method of *accouchement forcé*, and should be employed whenever possible. It is particularly indicated in cases of placenta prævia, and will be referred to more fully under that head. The entire literature upon the subject was well reviewed by Bürger in 1906.

*Instrumental Dilatation.*—Various instruments have been devised to effect the rapid and complete dilatation of the cervical canal, but to my mind none of them are as satisfactory as manual dilatation.

Leopold, in 1902, introduced into Germany the use of Bossi's powerful dilator, which was first employed by its inventor in 1889. This consists of four heavy blades, arranged as compound levers and operated by a screw handle. Leopold was most enthusiastic concerning it, and two years later his assistant, Ehrlich, reported 47 cases in which it had been used in his clinic. This hearty indorsement led to its trial, in various modifications, in all parts of the world; but the verdict concerning it is not unanimous, as Bardeleben, Lewis, Bar, and many others hold that it is a most dangerous instrument, and readily leads to deep cervical tears.

I have had no experience with its use; for, while there can be no doubt as to its dilating power, it seems to me that its sphere of usefulness is very limited. If the cervix is undilated and rigid, its employment must be dangerous; whereas, on the other hand, when the resistance of the internal os has already been overcome, equally satisfactory results may be obtained by other methods. Moreover, if cervical tears cannot be entirely avoided in manual dilatation, when the resistance of the cervix can be



accurately gauged by the operating hand, they must occur far more frequently when the dilating force is applied more or less blindly by means of a powerful steel compound lever. It is interesting to note that a similar instrument was devised in 1892 by Dr. H. S. Lott, of Salem, N. C., quite independently of Bossi's invention.

*Deep Cervical Incisions.*—When rapid delivery is urgently indicated in cases in which the cervical canal is obliterated but the external os not dilated, Dührssen recommended, in 1890, that multiple incisions be made through the vaginal portion of the cervix, which are united by sutures after the completion of labor. The technique of the operation is comparatively simple, as the incisions are readily made by means of scissors; but it has not been generally adopted, as there is no means of preventing further tearing of the incisions as the child is extracted, so that deep cervical lacerations frequently result, which may give rise to profuse hæmorrhage and prove most difficult to repair.

*Vaginal Cæsarean Section.*—This operation, which is better designated as vaginal hysterotomy, was first described by Dührssen in 1896, but did not come into general use for some years later on account of the polemical manner in which its inventor urged its claims.

In my opinion it affords the ideal method for rapidly terminating pregnancy whenever the cervix is undilated and rigid, and is far superior to brutal attempts at manual or instrumental dilatation. Unfortunately, it requires considerable surgical skill on the part of the operator, as well as specially devised specula, and the aid of several trained assistants, so that its use must be limited to hospital practice or that of trained specialists.

After the usual preparations for operation, a heavy traction suture is introduced through either side of the cervix. The latter is then drawn down as near as possible to the vulva, and a longitudinal incision made through the anterior vaginal wall from a little above the urethra to the anterior lip of the cervix (Fig. 343). The bladder is then separated from the entire anterior surface of the uterus by means of a finger covered by a piece of gauze. The first part of the separation is done by touch alone, but later a large retractor, such as that of Pryor, with a blade measuring  $5 \times 12$  centimeters, is introduced into the wound, after which the process is completed under the guidance of the eye, the bladder being drawn up behind the retractor, when the entire wall of the uterus, from the anterior lip of the cervix to above the contraction ring, is freely exposed. The anterior wall of the cervix and lower uterine segment is then incised for a distance of about 10 centimeters by means of a pair of heavy scissors (Fig. 344), and, after removing the speculum, the hand is introduced into the uterus, ruptures the membranes, and turns the child. After its extraction and the expression of the placenta, the speculum is again introduced, and, by making the traction sutures taut, the entire wound becomes visible as a triangular opening. Its edges are then united from above downward by interrupted catgut sutures, which are introduced under the guidance of the eye, after which the vaginal incision is closed by a continuous catgut suture (Fig. 345).

The anterior incision affords sufficient space for the extraction of the child up to the eighth month of pregnancy, but after that period a posterior incision is also necessary. In this event, the operation is begun by making a transverse incision in the posterior fornix at the cervical junction, and peeling off the peritoneum from the posterior wall of the cervix and lower uterine segment, which is then incised for a distance of 5 centimeters, after which the anterior wall is treated as has been described. The necessity for the double incision is readily understood, when one recalls that the suboccipito-bregmatic circumference of the fully developed head measures

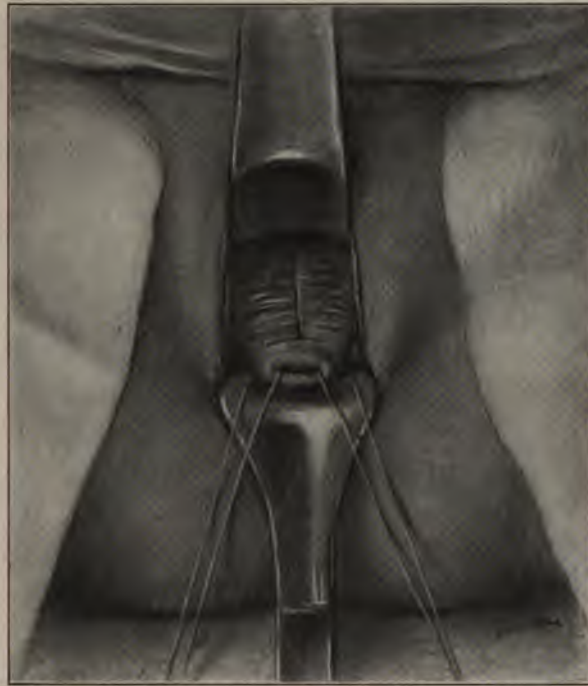


FIG. 343.—VAGINAL CÆSAREAN SECTION. EXPOSURE OF CERVIX AND PRIMARY INCISIONS.

32 centimeters, so that if only an anterior incision is made, it must measure 15 to 16 centimeters in length to permit the passage of the head without laceration of its upper end; whereas if the incisions are double, each requires to be only half so long. In the latter event, the posterior wound should be closed first.

In competent hands this operation permits the delivery of the child in ten minutes or less, no matter what the condition of the cervix, and the entire operation requires but thirty to forty minutes for its completion. Its advantages over manual or instrumental dilatation are that it leaves a clear-cut wound, properly united by sutures, in place of an irregular, deep, cervical laceration, which may extend into the lower segment, and which frequently cannot be properly repaired. If the incisions are made in the



median line, the amount of hæmorrhage is surprisingly small, and, if a suitable large retractor is employed, every step of the operation is readily visible.

I consider that the difficulties which are sometimes encountered in its performance are usually due to two factors: first, that the speculum employed is too small to give a suitable exposure of the field of operation; and, second, that the incision is either too short or not in the mid-line of the uterus. In the latter event laceration occurs at its upper end and extends obliquely outward, giving rise to profuse hæmorrhage. Dührssen

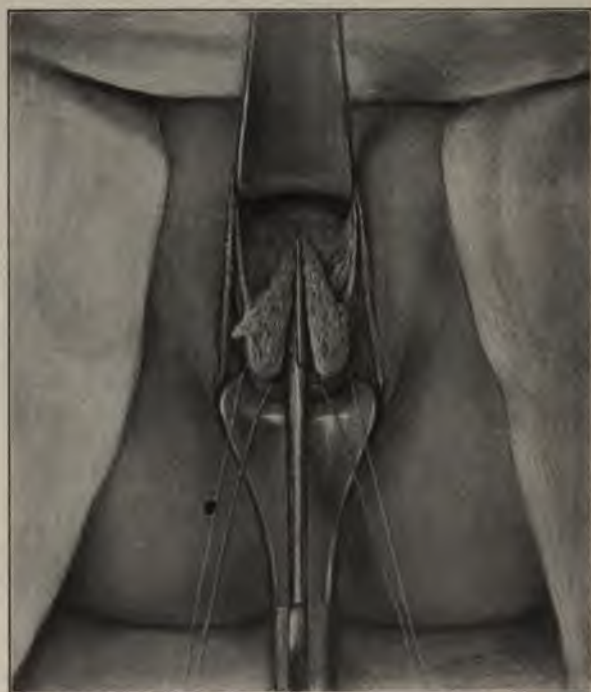


FIG. 344.—VAGINAL CÆSAREAN SECTION. INCISION OF ANTERIOR UTERINE WALL AFTER SEPARATION OF BLADDER.

pointed out that there was a tendency to relaxation of the uterus after the operation, and advised that the cavity be packed with gauze as a prophylactic against such an accident. I believe that this is a wise precaution, and always introduce the pack before laying the sutures in the anterior wall.

Dürrssen in 1909 stated that the technique of the operation could be facilitated by introducing a medium-sized rubber balloon into the uterus, which, after being filled tightly with sterile salt solution, is used as a tractor, the anterior wall of the cervix and lower uterine segment being incised over it until it slips out.

The merits of the operation were discussed at the 1905 meeting of the German Gynæcological Congress, when the consensus of opinion was in

its favor, Bumm stating that he had performed it in 52 instances. My own favorable opinion is based upon 50 operations performed in my service up to January, 1912. Peterson advocates it enthusiastically, and Winter reported to the International Medical Congress held at Budapest that the mortality was only a trifle over 1 per cent. in 446 cases which he collected from the literature. A full account of the operation, together with a list of

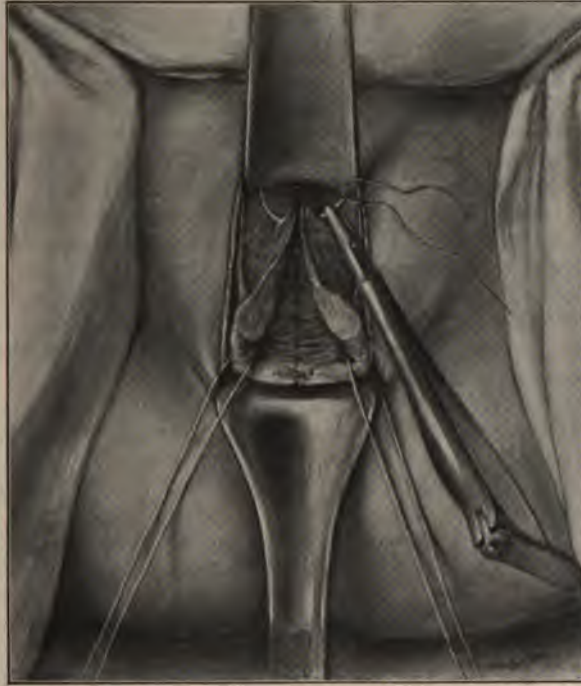


FIG. 345.—VAGINAL CÆSAREAN SECTION. LAYING OF SUTURES IN ANTERIOR INCISION. POSTERIOR INCISION ALREADY SUTURED.

all cases reported up to 1905, will be found in Dührssen's article in Winckel's *Handbuch der Geburtshilfe*.

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## CHAPTER XX

### FORCEPS

The obstetrical forceps is an instrument designed for the extraction, under certain conditions, of the child when it presents by the head. It consists of two branches which cross one another, and are designated right and left, respectively, according to the side of the pelvis to which each corresponds. They are introduced separately into the genital canal and are articulated after being placed in position. Each branch is made up of four portions—the handle, blade, shank, and lock.

The instruments vary considerably in size and shape, as will be seen when certain varieties of forceps are considered. The blades possess a double curvature—the cephalic and the pelvic—the former being adapted to the shape of the child's head, the latter to that of the birth canal. The blades are more or less elliptical in shape, tapering toward the shank, and are usually fenestrated so as to allow of a firm hold upon the head. Cer-

tain authorities, however, prefer solid blades in the belief that they can be made less bulky.

The cephalic curves should be such as to permit the head to be grasped firmly, but without serious compression. The greatest distance between the two blades should not exceed 7.5 centimeters (3 inches), when they are



FIG. 346.—SIMPSON'S FORCEPS, CEPHALIC CURVE



FIG. 347.—SIMPSON'S FORCEPS, PELVIC CURVE.

articulated. The pelvic curve corresponds more or less to the axis of the birth canal, but varies considerably in different instruments. When the forceps is placed upon a plane surface, the tips of the blades should be about 8.8 centimeters ( $3\frac{1}{2}$  inches) higher than the handles. The latter are connected with the blades by the shanks, which give the requisite length to the instrument.

The two branches articulate at the lock, which varies widely in different instruments. The English type consists of a socket upon each branch, into which fits the shank of the other half of the instrument. This arrangement permits of ready articulation, but does not hold the blades firmly to-

gether. In the French lock a pivot is screwed into the shank of the left branch, while the right presents an opening which can be adjusted to it, the screw being tightened after articulation. The German lock is a combination of the two, the shank of the left branch bearing a pivot with a broad, flat head, while the right is provided with a notch which corresponds to the pivot. When the instrument is properly articulated the handles should fall together in such a way as to be conveniently grasped by one hand of the operator.



FIG. 348.—LOCK OF ENGLISH FORCEPS.



FIG. 349.—LOCK OF FRENCH FORCEPS.

**History.**—Crude forceps were in use from an early period, several varieties having been described by Albucasis, who died in 1112; but, as their inner surfaces were provided with teeth intended to penetrate the head, it is evident that they were intended for use only upon dead children.

The true obstetrical forceps was devised in the latter part of the sixteenth, or the beginning of the seventeenth century, by a member of the Chamberlen family. The invention, however, was not made public at the time, but was preserved as a family secret through four generations, and did not become generally known until the early part of the eighteenth century. Prior to that time version had been the only method which permitted the artificial delivery of an unmutilated child, and, accordingly, when that operation was out of the question and delivery became imperative, it was accomplished by means of hooks and crotchets, which usually led to the destruction of the child. Thus, before the invention of forceps, the use of instruments was synonymous with the death of the child, and frequently of the mother also, and tended to bring obstetrics into disrepute.

William Chamberlen, the founder of the family, was a French physician, who fled from France as a Huguenot refugee and landed at Southampton in 1569. He died in 1596, leaving a large family. Two of his sons, both of whom were named Peter, and designated as the elder and younger, respectively, studied medicine and settled in London. They soon became successful practitioners, and devoted a large part of their attention to midwifery, in which they became very proficient. They attempted to control the instruction of midwives, and in justification of their pretensions claimed that they could successfully deliver patients when all others had failed.

The younger Peter died in 1626 and the elder in 1631. The latter left no male children, but the former was survived by several sons, one of whom, born in 1601, was likewise named Peter. To distinguish him from



his father and uncle, he is usually spoken of as Dr. Peter, as the other two did not possess that title. He was well educated, having studied at Cambridge, Heidelberg, and Padua, and on his return to London was elected a Fellow of the Royal College of Physicians. He was most successful in the practice of his profession, and counted among his clients many of the royal family and nobility. Like his father and uncle, he attempted to monopolize the control of the midwives, but his pretensions were set aside by the authorities. These attempts gave rise to a great deal of discussion, and many pamphlets were written as to the morality of women in labor being attended by men, which he answered in a paper entitled "A Voice in Ramah, or the Cry of Women and Children as Echoed Forth in the Compassions of Peter Chamberlen." He was a man of considerable ability, and united at the same time some of the virtues of a religious enthusiast with many of the devious qualities of a quack. He died at Woodham, Mortimer Hall, Essex, in 1683, the place remaining in the possession of his family until well into the succeeding century. Formerly he was considered the inventor of the forceps, but, as we now know, this view was incorrect.

He left a very large family, and three of his sons—Hugh, Paul, and John—became physicians, and devoted special attention to the practice of midwifery. Of these Hugh (1630-1706) was the most important and influential. Like his father, he possessed considerable ability, and at the same time took a practical interest in politics. Some of his views not being in favor, he was forced to leave England, and while in Paris in 1673 attempted to sell the family secret to Mauriceau for 10,000 livres, claiming that by its means he could deliver in a very few minutes the most difficult cases. Mauriceau placed at his disposal a rhachitic dwarf whom he had been unable to deliver, and Chamberlen, after several hours of strenuous effort, was likewise obliged to acknowledge his inability to do so. Notwithstanding his failure, however, he maintained friendly relations with Mauriceau, and on returning home translated the latter's book into English. In his preface he refers to the forceps in the following words: "My father, brothers, and myself (though none else in Europe as I know) have by God's blessing and our own industry attained to and long practiced a way to deliver women in this case without prejudice to them or their infants."

Some years later he went to Holland and sold his secret to Roonhuysen. Shortly afterward the Medico-Pharmaceutical College of Amsterdam was given the sole privilege of licensing physicians to practice in Holland, to each of whom, under pledge of secrecy, was sold Chamberlen's invention for a large sum. This practice continued for a number of years, until Vischer and Van der Poll purchased and made public the secret, when it was found that the device consisted of one blade only of the forceps. Whether this was all that Chamberlen sold to Roonhuysen, or whether the Medico-Pharmaceutical College had swindled the purchasers, is not known.

Hugh Chamberlen left a considerable family, and one of his sons—Hugh (1664-1728)—practiced medicine. He was a highly educated, respected, and philanthropic physician, and numbered among his clients members of the best families in England. He was an intimate friend

of the Duke of Buckingham, and when he died the latter caused a statue to be erected in his honor in Westminster Abbey. During the later years of his life he allowed the family secret to leak out, and the instrument soon came into general use.

For more than one hundred years it was believed that the forceps was the invention of Dr. Peter Chamberlen, but in the year 1813 Mrs. Kembell, the housekeeper of a rich brewer who had purchased Dr. Peter Chamberlen's country house, found in the garret a trunk containing numerous letters and instruments, among the latter being four pairs of forceps, together with several levers and fillets. As is evident from the drawings, the forceps were in different stages of development,

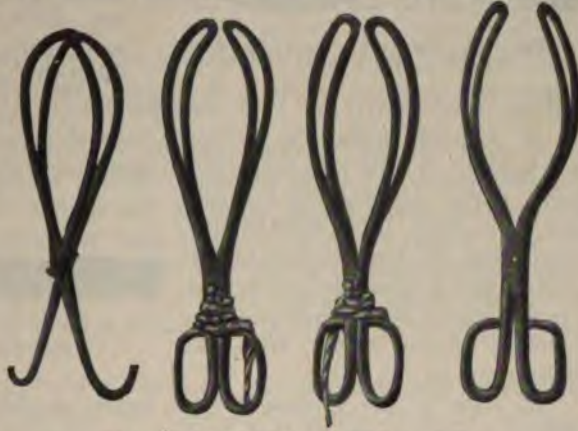


FIG. 350.—CHAMBERLEN'S FORCEPS.

one pair being hardly applicable to the living woman, while the others were useful instruments. Aveling, who has carefully investigated the matter, believes that the three pairs of available forceps were used respectively by the three Peters, and that in all probability the first was devised by the elder Peter, son of the original William. Probability is lent to this view by the fact that Dr. Peter, on one occasion, at least, spoke of the invention of his uncle. Snger and Budin, who have also investigated the subject, incline to the same belief.

The forceps came into general employment in England during the lifetime of Hugh Chamberlen, the younger. The instrument was used by Drinkwater, who died in 1728, and was well known to Chapman and Giffard. The former, writing in 1733, says:



FIG. 351.—PALFYN'S FORCEPS.

Dr. Chamberlen was the use of the forceps, now well known by all the principal men of the profession, both in town and country."

In 1723 Palfyn, a physician of Ghent, exhibited before the Paris academy of Medicine a forceps which he designated as *mains de fer*. It was crude in shape and did not articulate. In the discussion following its presentation, De la Motte stated that it would be impossible to apply it to the living woman, and added that if by chance any one should happen to invent an instrument which could be so used, and kept it secret for his own profit, he deserved to be exposed upon a barren rock and have his



vitals plucked out by vultures, little knowing that at the time he spoke such an instrument had been in the possession of the Chamberlen family for nearly one hundred years.



FIG. 352.—SMELLIE'S SHORT FORCEPS.

The Chamberlen forceps was a short, straight instrument, which possessed only a cephalic curve, and is perpetuated in the short or low forceps of to-day. It was used, with but little modification, until the middle of the eighteenth century, when Levret, in 1747, and Smellie, in 1751, quite independently of one another, added the pelvic curve and increased the length of the instrument. Levret's forceps was longer and possessed a more decided pelvic curve than that of Smellie, and it is from these two instruments that the long forceps of the present day is descended—the long French forceps being the lineal descendant of the former, and that of Simpson of the latter.



FIG. 353.—SHORT FORCEPS.

As soon as the forceps became public property it was subjected to various modifications, so that Mulder, in his atlas published in 1798, was able to give illustrations of nearly 100 varieties. Some idea of the desire to modify and improve the instrument may be gained by glancing at Wit-



FIG. 354.—LONG FRENCH FORCEPS (Levret).

kowski's *Obstetrical Arsenal*, in which are pictured several hundred forceps, which, after all, constitute only a small portion of those devised.

Poulet's interesting monograph contains an excellent historical sketch of the development of the instrument.

But, considering all the work done, it is surprising how little advance was made over the instruments of Levret and Smellie until 1877, when Tarnier clearly enunciated the principle of axis traction, which has since revolutionized our ideas upon the subject.

**Choice of Forceps.**—Inasmuch as it would appear that nearly every one interested in

obstetrics has thought it necessary to attempt to modify the forceps, and to have an instrument bearing his own name, the young physician is likely to be embarrassed by the multitude from which he has to choose. Any properly shaped instrument will give satisfactory results, provided it be



FIG. 355.—SMELLIE'S LONG FORCEPS.

used intelligently, but for general purposes the ordinary Simpson forceps is probably the best, though, if one expects to do much obstetrical work, a Tarnier axis-traction forceps becomes essential. Personally I always employ the latter, using the traction rods or not, according to circumstances, as I believe it better to become thoroughly familiar with one instrument than to have several for use under different conditions.

The forceps should be entirely of metal, so that it can be readily sterilized by boiling.

**Functions of the Forceps.**—This subject has been considered in detail by Chassagny. The forceps may be used as a tractor, rotator, compressor, dilator, lever, or irritator.

Its most important function is traction, exercised for the purpose of drawing the head through the genital tract. In not a few cases, however, particularly in occipito-transverse and posterior presentations, its employment as a rotator is attended by most happy results. It should never be used primarily as a compressor, though of course it is impossible to make traction without subjecting the head to a slight degree of compression; but when it is desired to bring about a diminution in its size other instruments are more appropriate.

Certain authors, especially in this country, advocate applying the forceps through a partially obliterated cervix, and assisting dilatation by traction upon the head. Such a procedure, however, is unjustifiable, for, when it becomes necessary to deliver the child under such conditions, the cervix should be stretched manually, and forceps not applied until dilatation is complete.

In rare instances one blade of the forceps may be employed as a lever, although at present use is very seldom made of this function. Formerly great stress was laid on the so-called dynamic action of the forceps, by which is meant the irritation of the uterus which follows its introduction. Before the employment of anaesthetics this function was of considerable importance, but at present it is of no significance.

**Indications for the Use of Forceps.**—Strictly speaking, the termination of labor by forceps, provided it can be accomplished without too great danger, is indicated in any condition which threatens the life of the mother or child. On the part of the mother, such conditions are eclampsia, heart lesions attended by broken compensation, acute œdema of the lungs, hæmorrhage from premature separation of the placenta, intrapartum infection, or exhaustion. Whenever there is question of interference for the last-named condition, definite objective symptoms should be present, the condition of the pulse being of especial importance; whereas, on the other hand, but little weight should be attached to the statements of the patient.

As regards the child, the operation may be called for by prolapse of the umbilical cord, premature separation of the placenta, undue pressure exerted upon the head, and especially by changes in the rhythm of its heart-beat and the escape of meconium in vertex presentations. A fetal pulse falling below 100, or exceeding 160 to the minute, indicates that the child is in danger and will perish if not promptly delivered. In vertex presentations the discharge of amniotic fluid tinged with meconium indicates interference



with the placental circulation and imperfect oxygenation, manifesting itself by paralysis of the sphincter ani. In breech presentations, on the other hand, the presence of meconium is without significance, being due merely to pressure exerted upon the child's abdomen.

In practice, however, the maternal indications for the use of forceps may be considerably extended, and in many instances the operation may be advisable in the case of women suffering from acute infectious diseases, heart lesions, and diseases of the respiratory tract, who must be saved as far as possible from the exhaustion incident to an unaided second stage of labor. Occasionally, also it may appear wise to relieve the strain upon a cicatrix resulting from a recent abdominal section.

One of the most frequent indications for the operation is afforded by faulty contraction of the uterine or abdominal muscles, the forceps being utilized merely to reinforce the insufficient *vis a tergo*. In occasional instances, particularly in elderly primiparae, the resistance offered by the perineum and the vaginal outlet may be so great as to oppose a serious obstacle to the passage of the child, even when the expulsive forces are normal. In uncomplicated cases, it is a good practical rule to apply forceps if advance does not occur after two hours of satisfactory second stage pains, but if the head is upon the perineum and no progress has been made for one hour in spite of good pains, it is usually not advisable to wait much longer. At the same time it must be insisted upon that the operation should never be performed to save the physician's time, but only when distinctly indicated by the condition of the mother or child.

*The following conditions must be fulfilled before forceps can be applied with safety:* (1) The child must present correctly; (2) the cervix must be fully dilated or dilatable; (3) the membranes must be ruptured; (4) the head of the child must be neither too large nor too small; and (5) the pelvis must not be too contracted.

The child should present by the vertex or face, and an accurate diagnosis be made as to the position and variety, forceps not being available when the chin is directly posterior. The forceps is not applicable to shoulder presentations, nor is it intended to be applied to the breech. It should not be employed in brow cases until after conversion into a vertex or face presentation has been brought about.

The cervix must always be completely dilated before the application of forceps, offering a diameter of from 9 to 10 centimeters. Of course it is possible to apply the blades through a canal measuring only 4 or 5 centimeters, but under such circumstances the cervical ring offers marked resistance, and, if the head be dragged through it by brute force, deep tears may result, which may implicate not only the cervix but also the lower uterine segment. Even if only gentle traction is made, the practice is not to be recommended, as it is difficult to know exactly when the cervix has become sufficiently wide to permit the passage of the head, and the operator is prone to attempt delivery before complete dilatation. Accordingly, if prompt delivery becomes imperative when the cervix is only partially dilated, its complete dilatation should be effected manually by Harris's method, after which forceps should be applied if the head is deeply engaged.

On the other hand, if it is only partially engaged, or is floating above the superior strait, and serious disproportion does not exist, delivery is best effected after podalic version, provided the uterus is not too tightly contracted.

The membranes should always be ruptured before applying forceps, for, if they intervene, the grasp upon the head is not so firm, and, what is still more important, traction upon them may bring about premature separation of the placenta.

Before applying forceps, particularly when engagement has not yet occurred, the size of the head should be determined as accurately as possible, for if it be unduly large, as in an excessively developed or hydrocephalic child, it cannot pass the superior strait. On the other hand, if it be abnormally small, it cannot be properly grasped, since the blades will slip off when traction is made. Accordingly, the employment of forceps is questionable when the fœtus is small or macerated.

Generally speaking, contracted pelvis presents an absolute contra-indication to the application of forceps; for, if the contraction be marked, it will be impossible to drag the head through the pelvis, and if brute force be employed it will result in the death of the child and severe injuries to the soft parts of the mother, and occasionally cause her death. On the other hand, when the contraction is but slight, and especially when the head is firmly engaged in the upper part of the pelvic cavity, the tentative application of forceps may be justifiable. Under such circumstances a few tractions of moderate intensity should be made; if the head follows they should be continued, but if not the forceps should be removed and delivery effected in some other manner.

**Preparations for Operation.**—When the application of forceps becomes necessary, either in the interests of the mother or child, the physician



FIG. 356.

ROBB'S LEG-HOLDER.

should inform a responsible member of the family of his decision. It is not advisable to inform the patient until the preparations for operation are completed.

Whenever possible, the patient should be placed upon a table of suitable height, as ordinary beds are too low and too soft for convenience. Anæsthesia should always be employed, and whenever practicable its administration should be intrusted to a competent assistant, rather than to the nurse or some member of the family, since in the latter case a large part of the obstetrician's attention must of necessity be devoted to watching the general condition, instead of being concentrated upon the operation.



When anaesthesia is complete, the patient's buttocks should be brought to the edge of the table, and her legs held in position by an appropriate leg-holder, which is particularly convenient in private practice, as it enables one to dispense with assistants for holding the legs. After the pubic hairs have been shaved, the genitalia should be thoroughly washed with soap and

hot water, bathed with alcohol, and thoroughly soaked in a 1 to 1,000 bichlorid solution, and the bladder emptied by catheter. Disinfection of the vagina is not necessary, unless the patient is infected or has been subjected to previous attempts at delivery. The legs and body should be covered with sterile towels in such a manner as to leave only the genitalia exposed, special attention being given to covering the anus so as to prevent contamination from the faeces. (See Figs. 335 and 336.)

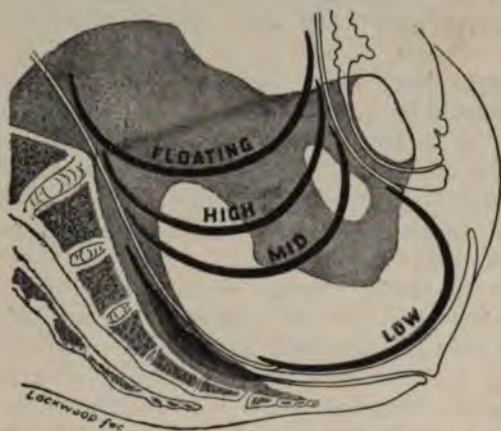


FIG. 357.—DIAGRAM SHOWING POSITION OF HEAD IN VARIOUS FORCEPS OPERATIONS.

Except when the outlet is relaxed, it is advisable to dilate it thoroughly by means of the hand before beginning the operation. For this purpose the fingers, anointed with sterile vaseline, are arranged in the form of a cone, and with a rotary motion slowly introduced through the vulva until the entire hand can readily be carried up into the vagina.

**Application of Forceps.**—Forceps operations are designated as low, mid, high, and floating, according to the position of the head. When the presenting part rests upon the perineum, or lies below the line joining the ischial spines, we speak of *low forceps*; when it presents at or just above the ischial spines, *mid forceps*; when the head has partially descended into the pelvic canal, but its greatest circumference has not passed the superior strait, *high forceps*; and when it is freely movable above the pelvic brim the operation is termed *forceps upon the floating head*.

The low forceps operation usually offers but little difficulty, except in certain funnel-shaped pelvises, and may be undertaken upon comparatively slight indications. The mid operation is more difficult, but not often excessively so. On the other hand, the high operation is always difficult, and should not be attempted unless imperatively demanded by the condition of the mother or child. Forceps upon the floating head is a most serious procedure, and is very rarely indicated. Generally speaking, the fact that the head is not engaged indicates some disproportion between it and the superior strait, so that the operation should not be thought of until accurate information as to the size of both is available. Moreover, in those cases in which there is no serious disproportion, delivery can usually be accomplished more safely and rapidly by version.

The forceps is so constructed that its cephalic curve is best adapted to the sides of the child's head, the biparietal diameter corresponding to the



FIG. 358.—FORCEPS CORRECTLY APPLIED ALONG OCCIPITO-MENTAL DIAMETER, PELVIC CURVE TOWARDS OCCIPUT.



FIG. 359.—FORCEPS CORRECTLY APPLIED ALONG OCCIPITO-MENTAL DIAMETER, PELVIC CURVE TOWARDS FACE.



FIG. 360.—FORCEPS APPLIED TO FACE ALONG OCCIPITO-MENTAL DIAMETER.

*tal* or *jugo-parietal* diameter. This is known as the *cephalic*, in distinction to the *pelvic* application. The former was recommended by

line of greatest distance between the blades. The head is grasped in an ideal manner when the long axis of the blades corresponds to the occipito-mental diameter, the fenestra including the parietal bosses and the tips lying over the cheeks, while the concave margins of the blades look toward either the occiput or the face. With such a grasp the forceps obtains a firm hold and cannot slip off, and traction can be made in the most advantageous manner. On the other hand, when the forceps is applied obliquely with one blade over the brow and the other over the opposite mastoid region, the grasp is less secure, and the head is exposed to more injurious pressure. If one blade is accurately applied over the face and the other over the occiput, the instrument cannot be locked, while if the former is slipped down so as to lie only over the forehead the grasp is very insecure, and each traction tends to extend the head (see Figs. 362 and 363).

For these reasons, then, the forceps should be applied, when possible, directly to the sides of the head along its *occipito-men-*



Smellie and Baudelocque, but, as it is more difficult than the latter, it fell into disuse, and was not generally practiced until Pinard, Farabeuf, and Varnier demonstrated the inestimable advantages which it possessed over the pelvic application. In the latter, the left blade is applied to the left and the right blade to the right side of the mother's pelvis, no matter what the presentation, consequently the head is grasped satisfactorily only in the



FIG. 361.—FORCEPS APPLIED OBLIQUELY OVER BROW AND MASTOID REGION.



FIG. 362.—SHOWING THAT WHEN ONE BLADE IS APPLIED OVER OCCIPUT AND OTHER OVER THE FACE, FORCEPS CANNOT BE LOCKED.



FIG. 363.—SHOWING EXTENSION OF HEAD WHEN ONE BLADE IS APPLIED OVER BROW AND OTHER OVER OCCIPUT, EXPLAINING TENDENCY OF THE INSTRUMENT TO SLIP OFF.

simpler cases where the sagittal suture is directed antero-posteriorly. An accurate idea of the exact position of the head is absolutely essential

to the cephalic application. With the head low down, this can usually be obtained by examining with two fingers; but when it is higher up an absolute diagnosis can be made only *by locating the posterior ear*, which necessitates the introduction of the entire hand into the vagina. This, of course, requires profound anæsthesia, and is therefore practicable only just before introducing the forceps. Ordinarily, after locating the ear, the examining hand is not removed, but remains in place to serve as a guide for the introduction of the first blade, which should be applied over the posterior ear, no matter whether it be the right or left. This rule admits of exception in two instances only—namely, when the head is resting upon the perineum, when the sagittal suture usually extends antero-posteriorly, or when it is movable at the pelvic brim. Faulty diagnosis not infrequently gives rise to an improper application of forceps, and is one of the most frequent factors in converting what should be a simple procedure into a serious and difficult operation.

*Forceps Delivery with the Head at the Vulva.*—With the head in this position, the obstacle to delivery is usually due to insufficient expulsive force or to abnormal resistance on the part of the perineum. In such circumstances the sagittal suture usually occupies the antero-posterior diameter of the pelvic outlet, with the small fontanelle directed toward either the symphysis pubis or the concavity of the sacrum. In either event the forceps, if applied to the sides of the pelvis, will grasp the head in an ideal manner. Accordingly, the left blade is introduced to the left and the right blade to the right side of the pelvis, the mode of procedure being somewhat as follows: Two fingers of the right hand are passed into the left and posterior portion of the vulva and carried up the



FIG. 364.—LOW FORCEPS; INTRODUCTION OF LEFT BLADE TO LEFT SIDE OF PELVIS.



FIG. 365.—LOW FORCEPS; LEFT BLADE IN PLACE.





FIG. 366.—LOW FORCEPS; LEFT BLADE IN PLACE, INTRODUCTION OF RIGHT BLADE.



FIG. 367.—LOW FORCEPS; INSTRUMENT IN PLACE AND ARTICULATED.

vagina past the margins of the external os. The handle of the left branch is then seized between the thumb and two fingers of the left hand—just as in holding a pen—and the tip of the blade is gently passed into the vagina along the fingers of the right hand which serve as a guide. As it is introduced the handle is held almost vertically at first, but, as the blade adapts itself to the head, it is depressed, so that it eventually takes a horizontal position. The guiding fingers are then withdrawn, and the handle is left to itself or held by an assistant. In the same manner, two fingers of the left hand are then introduced into the right and posterior portion of the birth canal to serve as a guide for the right blade, which is held in the right hand and introduced into the vagina. The guiding fingers are now removed and all that remains to be done is to articulate the branches. Usually they lie in such a manner that they can be locked without difficulty; but when this cannot be done, first one and then the other blade should be gently moved until they are brought into such a position as to be articulated with ease.

When this has been accomplished, an examination is made to ascertain whether the blades have been correctly applied, or whether they inclose the lips of the cervix. In the latter case the forceps should be loosened and reapplied. When it is certain that the blades are satisfactorily placed, the handles are

seized with one hand and gentle intermittent traction is made in a horizontal direction until the perineum begins to bulge. As soon as the vulva becomes distended by the occiput, the handles are gradually elevated, so that they come almost in contact with the abdomen of the patient as the parietal bosses emerge. During the latter manœuvre, the four fingers should grasp the upper surface of the handles and shanks, while the thumb upon their lower surface exerts the necessary force.

In delivering the head nature's method should be simulated as closely as possible. Accordingly, traction should be made intermittently, the head being allowed to recede in the intervals, as in spontaneous labor. Except when urgently indicated, it should be extracted very slowly, so as to give time for proper stretching and dilatation of the perineum,



FIG. 368.—LOW FORCEPS; HORIZONTAL TRACTION.



FIG. 369.—LOW FORCEPS;  
UPWARD TRACTION.

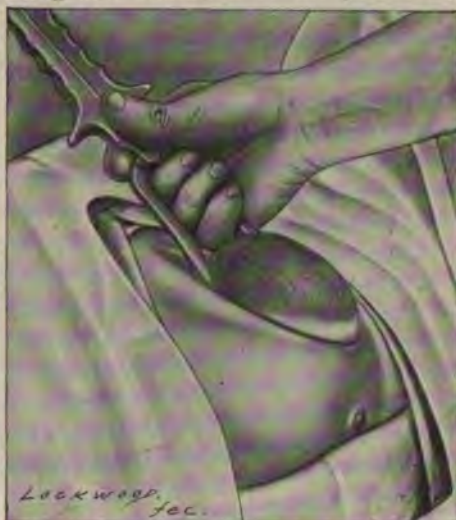


FIG. 370.—LOW FORCEPS;  
EXTREME UPWARD TRACTION.

which in primiparous women cannot be satisfactorily accomplished in less than from ten to fifteen minutes.

As soon as the vulva is well distended by the head, the forceps should be removed, and the head slowly expressed by pressure upon the pos-



terior portion of the perineum, in the belief that by so doing the liability to perineal rupture is diminished. Many operators, however, leave the forceps in place until the head is completely born, holding that in this way it is possible to exercise far more control over its advance, the increased distention of the vulva due to the thickness of the blades being so slight as to be without practical importance.

When the occiput is directed posteriorly, traction should be made in a horizontal direction until the forehead or root of the nose engages under the sym-



FIG. 371.—LOW FORCEPS; OCCIPUT DIRECTLY POSTERIOR; HORIZONTAL TRACTION (Farabeuf and Varnier).

physis, after which the handles should be slowly elevated, until the occiput slowly emerges over the anterior margin of the perineum, and then, by imparting a downward motion to the instrument, the forehead, nose, and



FIG. 372.—LOW FORCEPS; OCCIPUT DIRECTLY POSTERIOR; UPWARD TRACTION (Farabeuf and Varnier).

chin will successively emerge from the vulva. This extraction is more difficult than when the occiput is anterior, and, owing to the greater distention of the vulva, perineal tears are more liable to occur.

*Mid Forceps Operations.*—When the head lies above the perineum, the sagittal suture usually occupies an oblique or transverse diameter of

the pelvic canal. In such cases the forceps should be applied to the sides of the head. This is best accomplished by introducing two or more fingers into the vagina sufficiently deeply to feel the posterior ear, over which, no matter whether it be the right or left, the first blade should be applied.

In left occipito-anterior positions the entire right hand, introduced into the left posterior segment of the pelvis, should locate the posterior ear, and at the same time serve as a guide for the introduction of the left branch of the forceps, which is held in the left hand and applied over the posterior



FIG. 373.—MID FORCEPS; HAND IN VAGINA SEEKING POSTERIOR EAR.



FIG. 374.—MID FORCEPS; INTRODUCTION OF FIRST BLADE.

ear. The guide hand is then withdrawn, when the handle of the forceps may be held by an assistant or left to itself, as it will usually retain its position without difficulty.

Two fingers of the left hand are then introduced into the right and posterior segment of the genital canal, no attempt being made to reach the anterior ear, which lies in the neighborhood of the right ilio-pectineal eminence. The right branch of the forceps, held in the right hand, is then introduced along the left hand as a guide. After its introduction it still remains to apply it over the anterior ear of the child. This is accomplished by gently rotating it anteriorly until it comes to lie directly opposite the blade which was first introduced. The two branches being now articulated, one blade of the forceps occupies the posterior and the other the anterior extremity of the left oblique diameter (see Figs. 374 to 377).

In the right positions, the blades are introduced in a similar manner but in opposite directions, for in this case the right is the posterior ear, over which the first blade must be applied (see Figs. 378 to 380).

If the occiput is in a transverse position, the forceps is introduced in a similar manner, the first blade being applied over the posterior ear, and



the second being rotated anteriorly until it comes to lie opposite the first. In this case one blade lies in front of the sacrum and the other behind the symphysis.

Whatever the original position of the head may be, delivery is effected by making traction obliquely downward until the occiput appears at the vulva, the rest of the operation being completed in the manner already described. When the occiput is obliquely anterior, it gradually rotates spontaneously to the symphysis pubis as traction is made. But when it is directed transversely, in order to bring it to the front, it is sometimes necessary to impart a rotary motion to the forceps while making traction. The direction in which this is to be made varies, of course, according to the position of the occiput, rotation from the left side toward the middle line being necessary when the occiput is directed toward the left, and in the reverse direction when it is directed



FIG. 375.—MID FORCEPS; INTRODUCTION OF SECOND BLADE.

toward the right side of the pelvis (see Figs. 378, 379).

In making traction, before the head appears at the vulva, one or both hands may be employed according to the amount of force required. In the latter case, when the Simpson forceps is used, one hand grasps the handles of the instrument, while the fingers of the other are



Fig. 376.



Fig. 377.

FIGS. 376, 377.—MID FORCEPS; INSTRUMENT APPLIED IN L. O. A.

hooked over the transverse projection at their upper ends. Care must be taken not to employ too much force. To avoid this error the operator should stand or sit with his arms flexed and the elbows held closely against the thorax, as it is not permissible to make use of the body weight, and still less to brace the feet against the side of the bed (Fig. 381).

*Application of Forceps in Obliquely Posterior Positions.*

—Prompt delivery may become necessary when the small fontanelle is directed toward one or other sacro-iliac synchondrosis—namely, in R. O. P. and L. O. P. presentations. When interference is



Fig. 378.



Fig. 379.

FIGS. 378, 379.—MID FORCEPS; INSTRUMENT APPLIED IN R. O. T.

required in either of these, the head usually lies at or below the level of the ischial spines, and is usually imperfectly flexed.



FIG. 380.—MID FORCEPS; ROTATION TO R. O. A.

In many cases, when the hand is introduced to locate the posterior ear, the occiput will rotate spontaneously from a posterior to a transverse position, and delivery by forceps is then readily accomplished, as already described. If, however, rotation does not occur, the head should be seized, with four fingers over its posterior and the thumb over its anterior ear, and an attempt made to rotate the occiput to



a transverse position. This can usually be accomplished with ease, and occasionally even rotation to an anterior position can be brought about. The forceps is then applied as described above.



FIG. 381.—SHOWING MANNER OF MAKING TRACTION IN MID FORCEPS OPERATION

In a small proportion of cases, however, manual rotation cannot be effected, and the forceps must then be applied with the occiput still di-



Fig. 382.



Fig. 383.

FIGS. 382, 383.—DIAGRAMS SHOWING ROTATION OF OCCIPUT TO SACRUM AND SYMPHYSIS PUBIS RESPECTIVELY.

rected obliquely posterior. Under these circumstances, if the instrument be applied to the sides of the head, or even obliquely, and an attempt

made to effect delivery by making traction in the usual manner, great difficulty is experienced and very powerful traction becomes necessary, which, nevertheless, usually fails to bring about the desired result. It is this experience which has given rise to the great dread in which these presentations are generally held, and it is a very good practical rule, whenever unexpected difficulty is experienced in delivering what is apparently a simple anterior presentation, to think of the possibility of a mistake in diagnosis and to reëxamine the patient. In the vast majority of such cases, the small fontanelle will be found directed toward one or other sacroiliac synchondrosis.

In order for delivery to occur, the head must be rotated so as to bring its sagittal suture into coincidence with the antero-posterior diameter of the pelvic outlet. This can be accomplished by rotating the occiput by means of the forceps, either through an arc of 45 degrees to the hollow of the sacrum, or through one of 135 degrees to the symphysis pubis. The latter is much more advantageous, for the reason that delivery in the former position is more difficult and also



Fig. 384.



Fig. 385.

FIGS. 384, 385.—SHOWING INVERSION OF FORCEPS WHEN ANTERIOR ROTATION FROM AN R. O. P. POSITION IS COMPLETED.

more likely to give rise to deep perineal tears (Figs. 382 and 383).

Unfortunately, when it is desired to rotate the occiput forward, the forceps, if applied to the sides of the head in the usual manner, with the pelvic curvature directed forward, becomes inverted by the time rotation is completed, so that the pelvic curve looks posteriorly, and an attempted delivery with the instrument in this position is liable to cause serious injury to the maternal soft parts (Figs. 384 and 385). In order to avoid this, it is best to remove and reapply the instrument. If one wishes to avoid this double application, the head may be seized obliquely with one blade over the anterior brow and the other over the posterior mastoid



region; but this is not advisable, as the procedure is more difficult for the operator and far more dangerous for the child.

The *double application of forceps*, which was recommended by Scanzoni many years ago, has given such excellent results in my hands that I employ it to the exclusion of all other methods, when the occiput cannot be rotated manually from its obliquely posterior position. As the right occipito-



Fig. 386.



Fig. 387.

FIGS. 386, 387.—SCANZONI'S MANŒUVRE; FIRST APPLICATION OF FORCEPS.

posterior variety is much the more frequent, I shall describe in detail the steps of the operation.

In the first application the blades are applied to the sides of the head with the pelvic curve looking toward the face of the child, whereas in the second manipulation it looks toward the occiput. For the first application (Figs. 386 and 387) the right hand is passed into the left posterior segment of the genital tract, and the posterior (right) ear



Fig. 388.



Fig. 389.

FIGS. 388, 389.—SCANZONI'S MANŒUVRE; SHOWING ROTATION TO TRANSVERSE POSITION.

sought for. Over it the left blade is applied. This is held in position by an assistant, while the operator's left hand is passed into the right side of the vagina and over it is introduced the right blade, which is then rotated anteriorly until it comes to lie opposite the blade first introduced. The forceps is then locked, its blades now occupying the left and the sagittal suture the right



Fig. 390.



Fig. 391.

FIGS. 390, 391.—SCANZONI'S MANŒUVRE; SHOWING ROTATION TO ANTERIOR POSITION FORCEPS INVERTED.

oblique diameter of the pelvis. Downward traction is then made until the head impinges upon the pelvic floor, when a rotary motion is imparted to the forceps by which the occiput is slowly rotated to a right transverse, and later on to an obliquely anterior position (see Figs. 388 and 391).

The forceps, having become inverted, must be taken off, and reapplied in the usual manner to the head, which now occupies



Fig. 392.



Fig. 393.

FIGS. 392, 393.—SCANZONI'S MANŒUVRE; SECOND APPLICATION OF FORCEPS.

a right anterior position, when delivery is readily accomplished. Some difficulty may arise in bringing about proper articulation, since the handle of



the left branch lying above the right cannot be locked, but this can be readily overcome by rotating the former around the latter so as to bring the lock into proper position (see Fig. 394). In left positions the blades are applied in a similar manner, but in the reverse direction.

By this method I have obtained most satisfactory results, and have been able to deliver many women with ease after the usual methods had failed. Indeed, my experience has been so satisfactory that I have ceased to dread occipito-posterior presentations, and now regard them with equanimity, feeling that delivery can be readily and safely effected when necessary.

To avoid the necessity of constantly bearing in mind which is the



FIG. 394.—SCANZONI'S MANŒUVRE; SHOWING DIFFICULTY IN ARTICULATING BLADES IN SECOND APPLICATION OF FORCEPS.

left and which the right branch of the forceps, it is a good practical rule for a beginner, after having made an accurate diagnosis of the position of the head, to articulate the forceps and to hold them before the vulva of the patient. In this way he readily appreciates how they should be applied, and which blade is to go over the posterior ear.

*High Forceps.*—As has already been said, the high are much more difficult than the mid or low forceps operations, and should not be undertaken unless urgent indications are present. If the head be well engaged, the forceps should be applied as in the mid or low operation, except

that, owing to the more elevated position of the head, the blades must be introduced for a greater distance into the genital tract.

On the other hand, if the entire head lies above the superior strait, or only a small segment of it is engaged, the use of forceps should be avoided if possible, as such a condition usually indicates considerable disproportion between the head and the pelvis. If, however, the operation appears to be called for, the forceps should be applied obliquely, one blade over the mastoid and the other over the opposite brow. To my mind this is the only condition in which the interests of the mother and child are not best served by applying the forceps directly to the sides of the head; but under these circumstances there are several contra-indications. In the first

place, as the pelvis is usually contracted, the sagittal suture will generally lie transversely, and, accordingly the blades of the forceps, if applied to the sides of the head, will occupy the extremities of the conjugata vera, and thus still further increase the disproportion. But more important still



FIG. 395.—DIAGRAM SHOWING DEFECT OF CEPHALIC APPLICATION OF FORCEPS WHEN HEAD IS AT SUPERIOR STRAIT; BLACK LINE INDICATING DIRECTION OF ACTUAL AND DOTTED LINE THAT OF IDEAL TRACTION (Farabeuf and Varnier).

is the fact that, since the shape of the birth canal makes it impossible for the forceps to conform to its axis, the posterior blade bridges over the anterior concavity of the sacrum and thus prevents the head from entering the pelvic cavity, and so defeats the very purpose for which the operation would be undertaken.

*Axis-traction Forceps.*—With the ordinary long forceps, the high and occasionally even the mid operation is comparatively difficult, strong traction being necessary to effect delivery. This is due to the fact that, owing to the shape of the birth canal and of the forceps, it is impossible to exert traction directly in the axis of the superior strait. The latter, as we know, would, if continued downward, pass through the lower portion of the sacrum; but, owing to the presence of the perineum, the extremity of the sacrum and the coccyx, it is impossible to depress the handles of the forceps sufficiently to permit of traction in the desired direction. As a consequence, a very considerable part of the force exerted is wasted in dragging the head against the symphysis instead of bringing it downward. Thus, Tarnier pointed out that a force of 40 pounds employed in an ordinary high forceps operation would be resolved into two forces—one of 30 pounds and the other of 26 pounds—the former being in the axis of the superior strait and serving to bring about descent, whereas the latter would be directed



against the symphysis pubis and would not only be wasted, but would actually retard delivery.

This defect in the forceps has long been recognized. Saxtorph, in

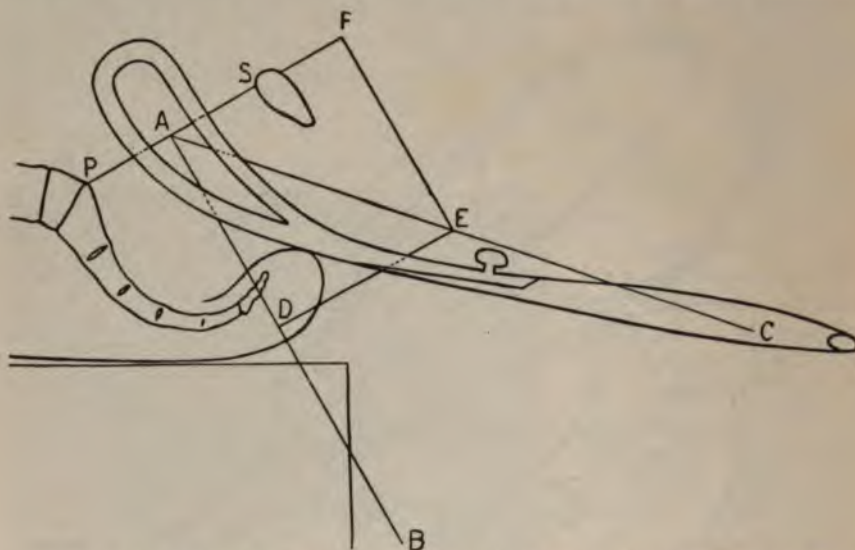


FIG. 396.—TARNIER'S DIAGRAM; SHOWING DEFECTS OF ORDINARY FORCEPS.  
A E C, line of actual traction; A D B, line of desired traction; A S F, force wasted against symphysis pubis.

1772, suggested that delivery could be greatly facilitated by attaching a lac to the eye of each blade and making traction upon these, as well as with the handles. He also showed that a similar result might be attained

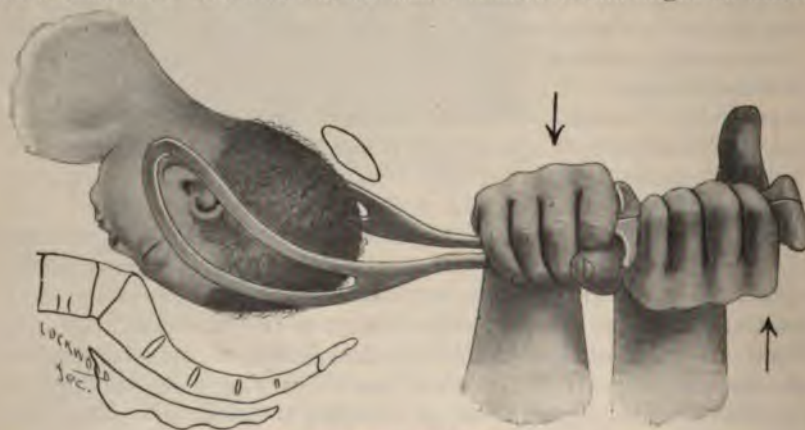


FIG. 397.—SAXTORPH-PAJOT MANŒUVRE.

by making strong downward pressure with one hand in the neighborhood of the lock, while the other was used for traction. This manœuvre is

usually attributed to Pajot, but was recommended by Saxtorph forty-four years before his birth.

Hermann, of Berne, in 1844, was the first to attempt to overcome the difficulty by devising an axis-traction forceps, his crude instrument being shown in Fig. 398. Hubert, of Louvain (1860), found that in certain cases, by turning the handles downward, he could make traction along the axis of the superior strait, his instrument giving ideal results when the sagittal suture was directed antero-posteriorly, but being useless in all other positions. Moralès (1871) added a perineal curve to the forceps, but his invention possessed the same disadvantages as that of Hubert. None of these instruments were of much practical value, but they served to emphasize the faults of those in general use.

Finally, in 1877, Tarnier solved the problem by attaching a traction-rod to each blade and fastening them to a handle. His original forceps possessed a definite perineal curve, and was very cumbersome. The importance of his invention was soon recognized, and obstetricians throughout the world promptly attempted to improve upon it; so that at present

one or more modifications of axis-traction forceps, each designated by the name of the modifier, are to be found in every large city. One of the most important was devised by Milne Murray and enjoys great



FIG. 398.  
HERMANN'S FORCEPS.



FIG. 399.—HUBERT'S FORCEPS.

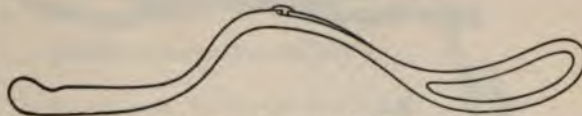


FIG. 400.—MORALÈS'S FORCEPS.



FIG. 401.—TARNIER'S ORIGINAL AXIS-TRACTION  
FORCEPS.

popularity in Great Britain, but to my mind it is inferior to the last Tarnier model.

Tarnier himself, not considering his original forceps satisfactory, con-



tinued to make changes and improvements, so that before his death he had devised an instrument which leaves little to be desired. It is practically



FIG. 402.—TARNIER'S FORCEPS; TRACTION RODS IN PLACE WITHOUT HANDLE-BAR.

a long French forceps without a perineal curve, provided with short, detachable traction-rods, one of which is inserted just beyond the eye of each

blade. When not in use, these are held in place by a pin upon the under surface of the shank, from which they can be readily freed, and attached by their free ends to a traction attachment which terminates in a handle-bar which can be grasped by one or both hands (see Figs. 402 and 403).

With this device, traction can be made almost in the axis of the superior strait, and, owing to the presence of numerous joints in the traction attachment, the instrument can be used in any position. The handles of the forceps merely serve to indicate the direction in which traction should be made, the force being applied to the handle-bar, which is held horizontally no matter what the position of the blades may be, the traction-rods being kept about one centimeter beneath the handles (Fig. 404).

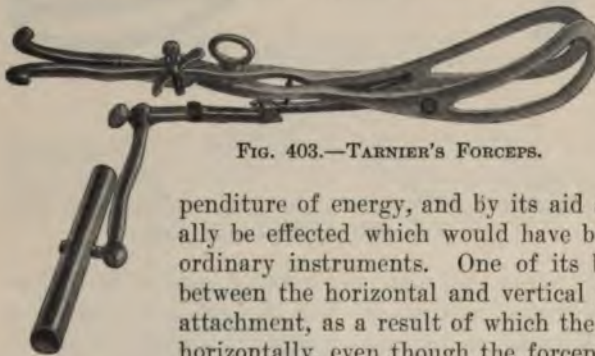


FIG. 403.—TARNIER'S FORCEPS.

To my mind, this instrument is superior to all other axis-traction forceps, and with it most excellent results can be obtained with a minimum ex-

penditure of energy, and by its aid a delivery can occasionally be effected which would have been impossible with the ordinary instruments. One of its best points is the joint between the horizontal and vertical portions of the traction attachment, as a result of which the handle-bar can be held horizontally, even though the forceps is applied at the ends of the antero-posterior diameter of the pelvis. I use this

instrument in all cases, without the traction-rods in low and mid, and with them in high forceps operations.

*Application of Forceps in Face Presentations.*—In face presentations the application of forceps occasionally becomes necessary, but is usually successful only in the transverse and anterior varieties, the blades being applied to the sides of the head along the mento-occipital diameter, with the pelvic curvature directed toward the neck. Traction is made in a downward direction until the chin appears under the symphysis; then by an upward movement the face is slowly extracted through the vulva, the nose, eyes, brow, and occiput appearing in succession over the anterior margin of the perineum.

Forceps should not be applied when the chin is directed toward the hollow of the sacrum, as delivery cannot be effected in this position. In

exceptional cases, if version is out of the question, and conversion into a vertex presentation cannot be effected, an expert operator may endeavor to rotate the chin to a transverse and later to an anterior position before resorting to pubiotomy or craniotomy, though such attempts are rarely successful.

*Application of Forceps in Breech Presentations.*—Occasionally the application of forceps is recommended in frank breech presentations, the blades being applied over the trochanters. This is very rarely indicated, as delivery can usually be effected more satisfactorily by the methods to be mentioned in the following chapter.

From the time of Smellie, many authors have recommended the ex-

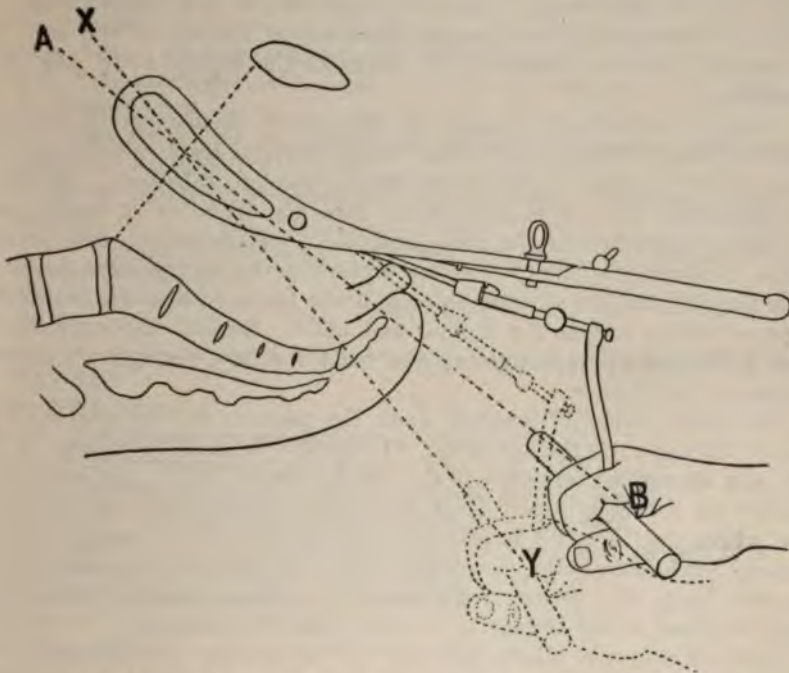


FIG. 404.—DIAGRAM SHOWING TRACTION WITH TARNIER'S FORCEPS.

A B in proper and X Y in improper manner (Ribemont-Dessaignes).

traction of the *after-coming head* in breech presentations by means of the forceps. In such cases the body of the child is carried up over the abdomen of the mother, and the blades are introduced under it and applied to the sides of the head. As a matter of fact, it is never necessary to resort to the forceps under such conditions, so its employment is not to be recommended, since the more expert one becomes in the use of Mauriceau's method of extraction the less frequently will difficulty be experienced in delivering the after-coming head.

**Prognosis.**—Low and mid forceps operations, when intelligently performed upon healthy women under proper aseptic precautions, should not



be followed by maternal mortality, the operation being undertaken to save maternal or foetal life.

It is generally held that perineal tears occur more frequently in forceps than in spontaneous deliveries. This, however, should not be the case, provided that the head is extracted sufficiently slowly. Unfortunately, it would appear as though the average operator, as soon as the head appears at the vulva, is seized with an almost uncontrollable desire to effect its immediate delivery by brusque traction, instead of imitating nature and devoting from fifteen to twenty minutes to overcoming the resistance of the perineum and vulval outlet. Leopold has stated that the forceps is the bloodiest of all obstetrical operations, and this is undoubtedly true if the child is rapidly dragged through a partially dilated birth canal by brute force. On the other hand, if properly employed, it is a means of sparing instead of destroying the perineum, inasmuch as the exit of the head can be controlled quite as effectively by means of the forceps as by any other procedure.

Attempts at delivery through an imperfectly dilated cervix are most dangerous, and frequently give rise to deep cervical tears, which may lead to the death of the patient from hæmorrhage or infection. Moreover, the application of forceps requires an accurate diagnosis as to the position and presentation of the child, and when this is lacking, and the forceps is incorrectly applied in certain occipito-posterior and brow presentations, delivery can be effected only by brute force, which can hardly fail to cause serious lesions for mother and child. Similar untoward results often follow an attempt to drag the head forcibly through a markedly contracted pelvic brim.

The foetal mortality depends upon the position of the head and the general difficulty of the operation. It should be practically zero in low and mid operations, except when a funnel-shaped pelvis has been overlooked. In a comparatively large experience, I can recall only two children whose deaths could be directly attributed to such operations when properly performed. On the other hand, the high forceps operation is attended by a very serious foetal mortality, which becomes still greater when the head is not engaged. In such cases the head may be subjected to injurious pressure, which may lead to the rupture of intracranial vessels and the subsequent death of the child. In rare instances actual fracture of the skull may occur, and occasionally the upper part of the occipital bone may become separated from its base.

Occasionally the child may be born with *facial paralysis*, or the condition may develop shortly after birth. This is usually noted when the head has been seized obliquely, and is due to the pressure exerted by the posterior blade of the forceps upon the neighborhood of the stylo-mastoid foramen, through which the nerve leaves the skull. Not every facial paralysis, however, following delivery by forceps, should be attributed to the operation, as such a condition is occasionally encountered after a spontaneous labor, and may be due to intracranial causes quite independent of the use of instruments. Full literature upon this subject up to 1901 will be found in Macé's article.

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## CHAPTER XXI

### EXTRACTION AND VERSION

#### EXTRACTION

**Extraction in Breech Presentations.**—The delivery of the child by traction when the feet protrude from the vulva in breech presentations was probably the earliest obstetrical operation.

From the time of Hippocrates, up to the beginning of the sixteenth century, head presentations alone were considered normal, and hence all the authorities, with the exception of Celsus, advised the conversion of breech into vertex presentations at any cost, even though it rendered necessary amputation of the limbs. After the resuscitation of podalic version by Ambroise Paré and Jacques Guillemeau, more rational views prevailed, so that in the seventeenth century we find Mauriceau advising the method of extraction which is in general use at the present time.

As the technique of the operation varies according as one has to deal with a complete breech or a foot, or with a frank breech presentation, it will be necessary to consider the two conditions separately. In both the essential prerequisite for the successful performance of extraction lies in the complete dilatation of the cervix and the absence of any serious mechanical obstacle. It is true that in a certain number of cases extraction through an imperfectly dilated cervix is possible, but this is usually effected only at the cost of deep cervical tears. Moreover, the additional resistance offered to the passage of the head will generally lead to its extension, the arms at the same time becoming elevated over it, thereby so complicating and delaying delivery that the child is almost invariably lost. For these reasons, premature extraction is indicated but rarely, and then only in the interests of the mother.

**Indications for Extraction.**—It has already been pointed out that the fetal mortality is considerably greater in breech than in vertex presentations, since in the former death from asphyxiation is almost inevitable if the head be not delivered in less than *eight minutes* after the appearance of the umbilicus at the vulva. In these cases the untoward result may be due to one or other of several causes. Thus, very often the cord is subjected to pressure between the pelvic brim and the head, which may be so severe as to check completely the circulation. Less frequently the rapid decrease in the size of the uterus, following the extrusion of the body of the child, results in premature separation of the placenta before the head is born, so that death becomes inevitable unless extraction is promptly effected.

In all breech presentations, preparations should be made for extraction as soon as the buttocks appear at the vulva, so that the operation can be promptly resorted to if, after the appearance of the umbilicus, the extrusion of the rest of the body does not rapidly follow. In a certain number of cases, no matter what the position of the breech, extraction may be called for by any condition which seriously threatens the life of the mother or child, just as in vertex presentations. When speaking of the latter, however, it was said that the passage of meconium indicated that the child was in danger, whereas in breech presentations such an occurrence is without significance, as it is simply the result of the compression to which the abdomen of the child is being subjected.

*Extraction by One or Both Feet.*—Before beginning the operation, the patient should be brought to the edge of the bed and subjected to the usual preliminary preparations. Complete anæsthesia is necessary, except in those cases in which the body of the child has already been born and only the head remains to be extracted.

As a rule, extraction is an extremely simple operation when the breech has been born spontaneously, whereas it is less so when the feet are in the vagina, or still within the uterus. In the latter case the entire hand should be introduced into the vagina and an attempt made to seize both feet, the ankles being grasped in such a manner that the second finger lies between them. They are then brought down into the vagina, and traction is made until they appear at the vulva. If, however, difficulty is experienced in seizing both feet, one should be grasped and extracted in a similar manner.

As soon as the feet have been drawn through the vulva, they should be wrapped in a sterile towel so that a firmer grasp may be obtained, since the vernix caseosa renders them so slippery that they are very difficult to hold. Traction is then made in a downward direction, and as the legs protrude still farther they are grasped higher up, first by the calves and later by the

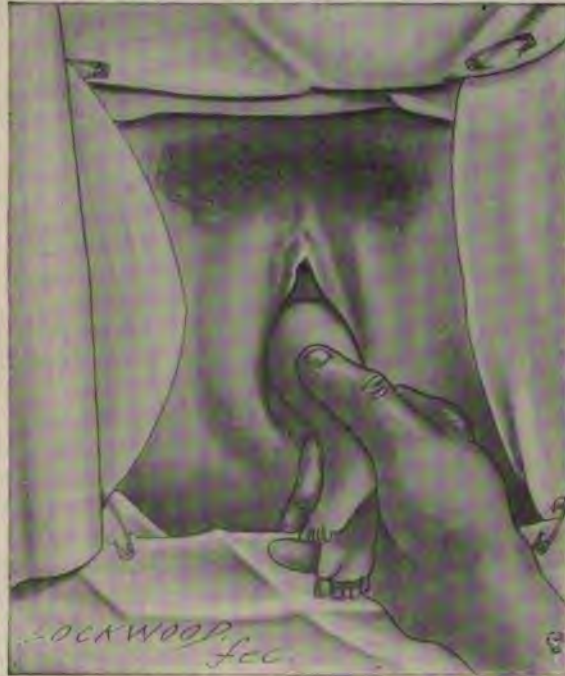


FIG. 405.—BREECH EXTRACTION; TRACTION UPON FEET.



thighs. When the breech appears at the vulva, traction is made in an upward direction until it is delivered. The thumbs are then applied over the sacrum and the fingers over the hips, and traction is continued in the same manner until the thorax is born, when the arms must be freed in order to effect delivery.



FIG. 406.—BREECH EXTRACTION; TRACTION UPON THIGHS.

If only one foot has been seized, traction should be made upon it until the buttocks appear at the vulva, when the index finger of the other hand is introduced into the posterior groin and aids in traction.

As soon as the operator begins to pull upon the legs, an assistant or the nurse should exert strong pressure upon the uterus in the axis of the superior strait, with the object of preserving the flexed attitude of the head and preventing the arms from becoming extended above it. Be-

sides serving these purposes it also aids directly in the expulsion of the child, and thus renders necessary a smaller amount of force on the part of the operator.

Downward traction should be continued until the scapulæ are at least partially outside of the vulva, and no attempt should be made to free and deliver the arms until this is effected, as failure to observe this rule frequently renders difficult what would otherwise be a very simple procedure. In a certain number of cases the arms are delivered spontaneously. With this in view, the child should be seized with the thumbs over the scapulæ and the fingers over the sides of the thorax and rotated until the bisacromial diameter occupies the antero-posterior diameter of the outlet. Then by continuing traction downward the anterior shoulder engages beneath the pubic arch, the hand and arm escaping spontaneously; while upon sharply drawing the feet up over the abdomen of the mother, the posterior shoulder, arm, and hand pass over the perineal margin.

In most cases, however, the process is not so simple, and it becomes necessary to *free and deliver the arms*. Since there is more available space in the posterior and lateral segments of the pelvis, the posterior arm should

be freed first. In order to do so, the thorax should be rotated until the bisacromial diameter occupies an oblique diameter of the pelvis (Fig. 407), and the feet should be sharply drawn up by one hand over the groin of the mother corresponding to the anterior shoulder. Then two fingers are introduced beneath the posterior shoulder and passed along the humerus until the elbow is reached (Fig. 408). The fingers are now applied in such a way as to serve as a splint to the arm, which is swept downward over the thorax and delivered from the vulva. To effect the delivery of the anterior arm, the body is seized as before and rotated so as to bring the undelivered shoulder into the neighborhood of the nearest sacro-sciatic notch. The legs are then carried upward, so as to bring the body to the opposite groin of the mother, and if the arm be not born spontaneously it is delivered in the same manner as the other.

If pressure from above has not been made—and occasionally in spite of it—the arms may become extended over the head. Under such circumstances their delivery, although more difficult, can be accomplished by the manœuvres ordinarily employed. In doing this, particular care must be taken to carry the fingers up to the elbow and use them as a splint, for, if the finger be merely hooked over the arm and strong traction made, the humerus or clavicle is exposed to great danger of fracture.

In other cases the arm is found around the back of the neck, when its delivery becomes still more difficult. If it cannot be freed in the manner just described, its extraction may be facilitated by rotating the child through half a circle in such a direction that the friction exerted by the birth canal will serve to draw it toward the face; but if this fails, it must be forcibly extracted by hooking a finger over it. Unfortunately, fracture of the humerus or clavicle is very common in such cases, and its probability should be pointed out to some responsible member of the family. Such an accident, however, is not very serious, as good union can always be secured by appropriate treatment.



FIG. 407.—BREECH EXTRACTION; POSTERIOR ROTATION OF SHOULDER.



After the shoulders have been born, the head usually occupies an oblique diameter of the pelvis with the chin directed posteriorly, when its extraction is best effected by *Mauriceau's* manœuvre (Figs. 409 and 410). For this purpose, the index finger of one hand is introduced into the mouth of the child and applied over the superior maxilla, while the body rests upon the palm of the hand and the forearm, with the legs straddling the latter. Two fingers of the other hand are then hooked over the neck, and, grasping the shoulders, make downward traction until the occiput appears under the symphysis. The body of the child is now raised up toward the mother's abdomen, and the mouth, nose, brow, and eventually



FIG. 408.—BREECH EXTRACTION; INTRODUCTION OF FINGERS TO FREE POSTERIOR ARM.

the occiput successively emerge over the perineum. Traction should be exerted only by the fingers over the shoulders, and not by the finger in the mouth; since in many cases the latter slips from the superior maxilla and comes to rest upon the inferior maxilla and base of the tongue, as a consequence of which serious injuries may be done to the child if energetic traction be employed.

This manœuvre was first practiced by Mauriceau in the seventeenth century, but for some reason fell into disfavor. Nearly a hundred years later Smellie described a similar procedure, but rarely made use of it, as he preferred the employment of forceps. In the meantime other devices came into use, until G. Veit, in 1863, directed attention to the inestimable advantages which Mauriceau's method of extraction possessed over all others.



FIG. 409.—BREECH EXTRACTION; MAURICEAU'S MANŒUVRE, DOWNWARD TRACTION.

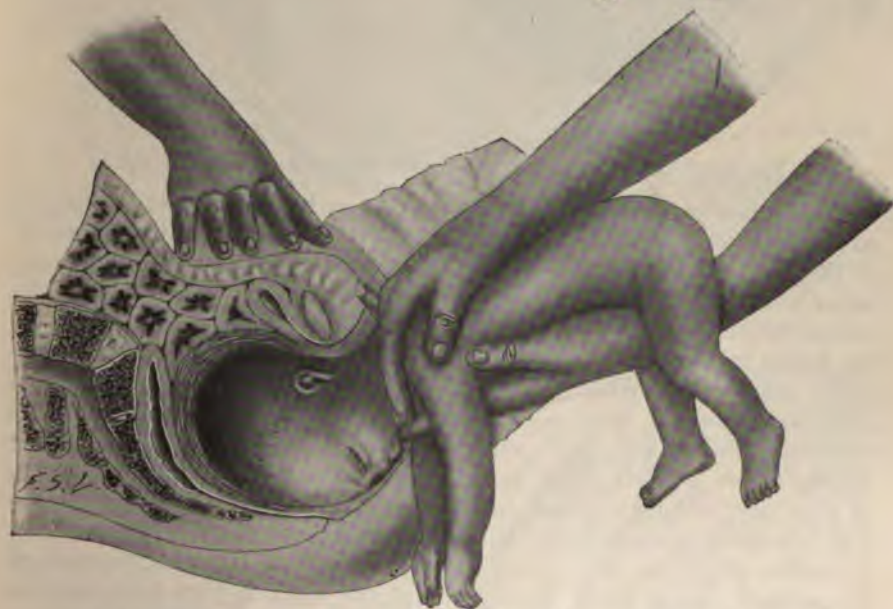


FIG. 410.—BREECH EXTRACTION; MAURICEAU'S MANŒUVRE, UPWARD TRACTION.



For this reason in Germany the procedure is frequently called after Veit, or, when greater accuracy is desired, is designated as the Mauriceau-Smellie-Veit manœuvre. Litzmann, however, was certainly right in pointing out the impropriety of such a nomenclature, and insisting that only the name of the original inventor—Mauriceau—should be used in describing it. Numerous other methods of extraction have been devised, Winckel being able in 1888 to collect 21 different procedures from the literature, although none has proved as serviceable as that of Mauriceau.

In the vast majority of cases the back of the child eventually rotates toward the front, no matter what its original position; but when it does



FIG. 411.—DELIVERY OF AFTER-COMING HEAD, PRAGUE MANŒUVRE.

not take place spontaneously the movement may be inaugurated by making stronger traction upon the leg, which would naturally rotate anteriorly. If this does not bring about the desired result, and the back remains posterior after the birth of the shoulders, extraction must be begun with the occiput posterior. As a rule, rotation can still be effected by means of the finger in the mouth, after which the head can be extracted by Mauriceau's manœuvre. When, however, this is impossible, delivery must be attempted, with the head in its abnormal position, by the employment of a modified *Prague manœuvre*, which is so called for the reason that its advantages were strongly urged and practiced more particularly by Kiwisch, of that city, although it had been described by Pugh a century earlier. The procedure is somewhat as follows: Two fingers of one hand grasp the shoulders, while the other hand draws up the feet over the abdomen of the mother. As a result the occiput of the child is born first and the perineum is necessarily subjected to greater liability of rupture.

*Prognosis.*—The prognosis, so far as the mother is concerned, is very favorable, even when considerable disproportion exists between the child and the pelvis, since the pressure of the head upon the maternal soft parts lasts but a few seconds, instead of being prolonged for hours, as in head presentations. Owing to the necessity of intra-vaginal manipulations, there is a slightly increased danger of infection, and, more particularly in the case of a primipara with a rigid vaginal outlet, there is greater liability to laceration of the perineum than in head presentations.

For the child, however, the outlook is not so favorable, and becomes more serious the higher the situation of the presenting part at the beginning of the operation. The foetal mortality is in great part due to the dangers inherent to breech presentations, which are augmented by the greater liability to the occurrence of traumatism during extraction, particularly if there is marked disproportion between the head and the pelvis.

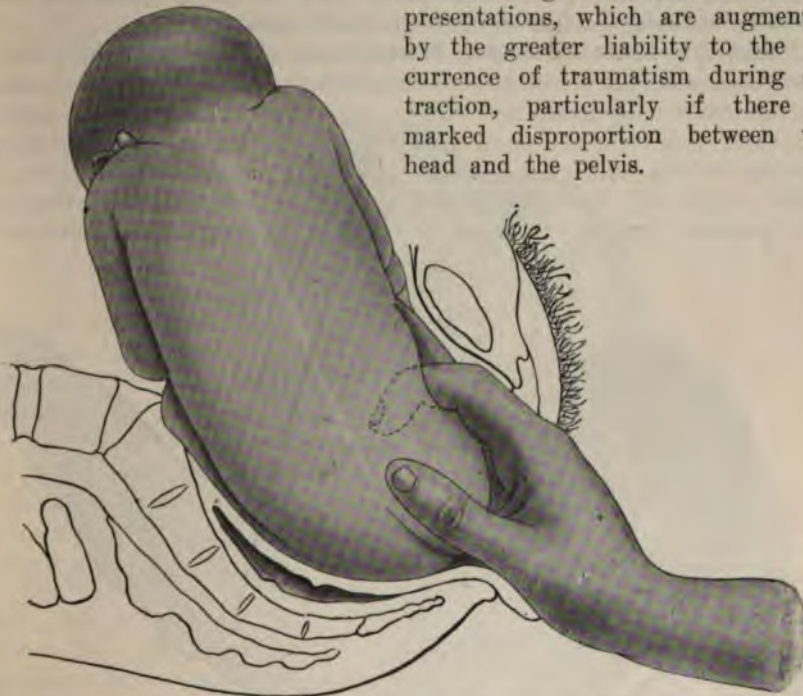


FIG. 412.—EXTRACTION OF FRANK BREECH; FINGER IN ANTERIOR GROIN.

As has already been said, fractures of the humerus and clavicle cannot always be avoided, even in the hands of expert operators. Occasionally *hæmatomata* of the *sterno-cleido-mastoid muscle* are noted after the operation, though these are usually of but slight significance and disappear spontaneously within a short time. More serious results, however, may follow the *separation of the epiphyses* of the scapula or humerus. In exceptional cases *paralysis of the arm* results from pressure exerted upon the brachial plexus by the fingers in making traction, but more frequently is due to an overstretching of the neck in freeing the arms or in effecting extraction by the Prague manœuvre. As will be shown in Chapter XLIII, the con-



dition usually undergoes spontaneous cure, although in rare instances it persists throughout life.

When the child is forcibly extracted through a markedly contracted pelvis, spoon-shaped depressions or actual *fractures of the skull* may result, which generally prove fatal, and occasionally when great force is employed even the neck may be broken.

The application of *forceps to the after-coming head*, introduced by Smellie, has been extensively practiced. In such circumstances the body of the child is elevated toward the abdomen of the mother and the forceps introduced under it, the blades being applied to the sides of the head. Personally, I have never found it necessary to resort to this procedure, and believe that it is but rarely called for if the obstetrician has made himself thoroughly familiar with Mauriceau's manœuvre.

**Extraction of Frank Breech Presentations.**—When indications for delivery arise after the breech has descended deeply into the birth canal, its extraction can usually be effected without difficulty by hooking the index finger of one hand into the anterior groin and the index finger of the other hand into the posterior groin in order to

out difficulty by hooking the anterior groin and appear at the vulva, the being then inserted into furnish additional aid.

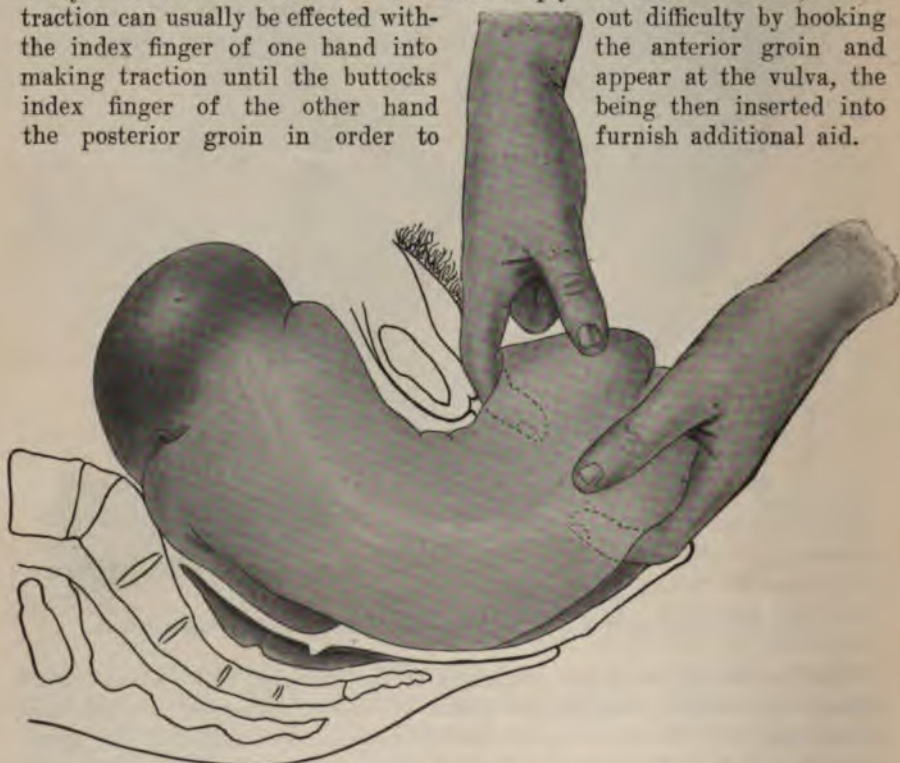


FIG. 413.—EXTRACTION OF FRANK BREECH; FINGERS IN GROINS.

On the other hand, when the breech is at the superior strait, delivery is much more difficult. In such cases it is advisable to try to decompose the wedge and to bring down one or both feet, which can be readily accomplished if attempted shortly after rupture of the membranes, but becomes extremely difficult if a considerable time has elapsed after the escape of

the liquor amnii and the uterus has become tightly contracted over the child.

In many cases the employment of the following manœuvre suggested by Pinard will often aid materially in bringing down the foot: Two fingers are carried up along one leg to the knee and push it away from the middle line. This procedure is usually followed by spontaneous flexion, and the foot of the child will be felt to impinge upon the back of the hand, when it can be readily seized and brought down (Fig. 414).

In view of the fact that it is often very difficult to seize and bring down a foot in the latter part of the second stage of labor, Ahlfeld and others have suggested the propriety of rupturing the membranes as soon as the cervix is fully dilated, and bringing down a foot prophylactically, so that a convenient tractor may be available in case extraction becomes necessary. This can be readily accomplished, but is not advisable as a routine practice, since the frank breech forms a much better dilating wedge than the incomplete breech presentation. The procedure is justifiable, however, in those cases in which it appears probable that rapid extraction may become imperative; for instance, in patients suffering from heart lesions.

If the indication for delivery is urgent, and it is impossible to bring down a foot, the child must be extracted as it lies. For this purpose the index finger of one hand is hooked into the anterior groin, and strong downward traction made, supplemented, if necessary, by the use of the other hand, which grasps the wrist. This procedure is continued until the posterior buttock has almost reached the pelvic floor, when the index finger of the other hand is hooked into the posterior groin and traction made with both

hands. As soon as the latter becomes accessible, delivery can usually be readily effected, but, unfortunately, in a considerable number of cases, it is extremely difficult to bring the breech low enough to offer this advantage. For this reason, when the breech is high up, its extraction should not be attempted unless imperatively demanded by the condition of the mother or child; otherwise it is far better to wait until it has descended lower before interfering.



FIG. 414.—PINARD'S MANCEUVRE FOR BRINGING DOWN A FOOT IN FRANK BREECH PRESENTATION.



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When the child is forcibly extracted through a markedly contracted pelvis, spoon-shaped depressions or actual *fractures of the skull* may result, which generally prove fatal, and occasionally when great force is employed even the neck may be broken.

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out difficulty by hooking  
the anterior groin and  
appear at the vulva, the  
being then inserted into  
furnish additional aid.

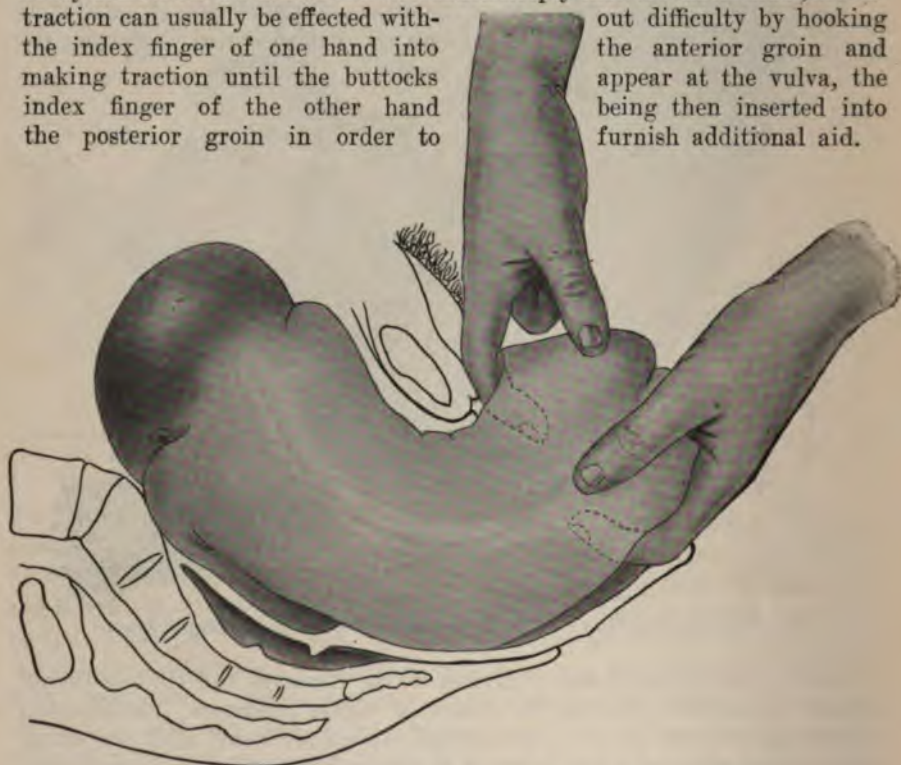


FIG. 413.—EXTRACTION OF FRANK BREECH; FINGERS IN GROINS.

On the other hand, when the breech is at the superior strait, delivery is much more difficult. In such cases it is advisable to try to decompose the wedge and to bring down one or both feet, which can be readily accomplished if attempted shortly after rupture of the membranes, but becomes extremely difficult if a considerable time has elapsed after the escape of

## VERSION

Version, or turning, is an operation through which the presentation of the foetus is artificially altered, one pole being substituted for the other, or an oblique or transverse being converted into a longitudinal presentation.

According as the head or breech is made the presenting part, the operation is spoken of as cephalic or podalic version, respectively. It is also designated according to the method by which it is accomplished. Thus we speak of *external version* when the manipulations are made exclusively through the external abdominal wall; of *internal version* when the entire hand is introduced into the uterine cavity; and of *combined version* when one hand manipulates through the abdominal wall, while two or more fingers of the other are introduced through the cervix.

**Cephalic Version.**—This operation was practiced from the most remote antiquity, and only gradually fell into disfavor after the introduction of podalic version by Paré and his followers. After the discovery of Wigand (1807) that the position of the child could easily be altered by external manipulations, cephalic version came into more general use, and since the publications of Hubert and Pinard has become a well-recognized procedure in certain conditions.

The object of the operation is to substitute a vertex for a less favorable presentation. As it does not, however, afford a means for immediate delivery, its field of usefulness is comparatively limited, and its employment is still further restricted by various contra-indications.

**Indications.**—If a breech or transverse presentation is diagnosed in the last few weeks of pregnancy, its conversion into a vertex should be attempted by external manœuvres, provided there be no marked disproportion between the size of the child and the pelvis. Cephalic version is indicated by reason of the increased foetal mortality attending spontaneous delivery in breech presentations; while if the child lies transversely a change of presentation is imperatively demanded, inasmuch as a natural labor is out of the question, and if appropriate measures are not adopted the lives of both mother and child will be lost.

Unfortunately, after the accomplishment of external cephalic version, the child tends to return to its original position. Consequently it is sometimes necessary for the patient to wear a suitable bandage until the new presenting part becomes engaged. Moreover, the operation can be accomplished only under the following conditions: (1) The presenting part must not be deeply engaged; (2) the abdominal wall must be sufficiently thin to admit of accurate palpation; (3) the abdominal and uterine walls must not be too irritable; (4) the uterus must contain a sufficient quantity of liquor amnii to permit the easy movement of the child. Given these essentials, external cephalic version should always be attempted, since it is absolutely harmless, and, if the new position is maintained, may do away with the necessity for serious operative procedures at the time of labor.

In the early stages of labor, before the membranes have ruptured, the



same indications hold good, and at this time may be extended to oblique presentations as well, though these usually right themselves spontaneously as labor progresses. On the other hand, external cephalic version can be effected but rarely after the cervix has become fully dilated and the membranes have ruptured, except in occasional cases of shoulder presentations; and, moreover, better results are obtained from podalic version followed by immediate extraction. This is particularly true in cases complicated by prolapse of the cord or placenta prævia. Serious pelvic contraction is a decided contra-indication, since, although version may be readily accomplished, the procedure is useless, as more radical operative measures will be necessary before delivery can be effected.

*Methods.*—Cephalic version may be brought about either by *external manipulations* alone, or by the combined method—with one hand on the



FIG. 415.—EXTERNAL CEPHALIC VERSION (Pinard).

abdomen and two or more fingers, or even the whole hand, in the uterus. During pregnancy the former is the only method applicable, and at the time of labor it should be employed whenever feasible. The technique has been carefully described by Pinard, and is somewhat as follows: The patient's abdomen having been bared, the presentation and position of the child are carefully mapped out. The fetal poles are then seized with either hand, and the one which we wish to present is gently stroked toward the superior strait, while

the other is moved in the opposite direction. After version has been completed, the child must be held in its new position until engagement occurs. During pregnancy this is accomplished by appropriately fitting pads, which are held in place by a bandage; but at the time of labor the head may be pressed down into the superior strait and held firmly in position until it becomes fixed under the influence of the uterine contractions.

At the time of labor, if external manipulations prove futile, cephalic version may be accomplished by the *combined or bipolar method of Braxton Hicks* as soon as the cervix is sufficiently dilated to admit of two fingers. For carrying out this procedure Hicks gave the following directions:

"Introduce the left hand into the vagina as in podalic version. Place the right hand on the outside of the abdomen in order to make out the

position of the fœtus and the direction of the head and feet. Should the shoulder, for instance, present, then push it with one or two fingers on the top in the direction of the feet. At the same time pressure by the other hand should be exerted upon the cephalic end of the child. This will bring the child close to the os. Then let the head be received upon the tips of the inside fingers. The head will then play like a ball between the hands, and can be placed at almost any part at will. . . . It is well, if the breech will not rise to the fundus readily and the head is fairly in the os, to withdraw the hand from the vagina and with it press up the breech from the exterior" (Fig. 421). While the credit for popularizing this procedure undoubtedly belongs to Hicks, it is interesting to note that it had been described by Marmaduke Wright, of Cincinnati, in 1854; ten years before the appearance of Hicks's first publication.

Busch, D'Outrepoint, and others advocated attempting cephalic version after complete dilatation of the cervix, by introducing one hand into the uterus and seizing the head, while the other is employed for external manipulations. This is rarely if ever advisable, as under such circumstances it is preferable to perform internal version, which is no more dangerous, and at the same time permits immediate delivery if necessary.

**Podalic Version.**—By this is understood the turning of the child by seizing one or both feet, and drawing them through the cervix, the operation being usually followed by extraction. Podalic version was introduced and warmly advocated by Paré, and, until the invention of the forceps, afforded the only means of artificially delivering unmutilated children. It is interesting to note that Guillemeau, one of Paré's students, was enabled by this means to save his master's daughter from dying of hæmorrhage due to placenta prævia. The value of the operation was recognized and insisted upon by Louise Bourgeois, Mauriceau, and among many others by De la Motte, who employed it very frequently with most excellent results.

**Indications.**—Podalic version is indicated in two great groups of cases—namely, in transverse or oblique presentations, and in head presentations in which it is believed that delivery can be more safely and more rapidly accomplished after version.

The necessity for version in transverse and oblique presentations is obvious. In abnormal head presentations, when the face, brow, or occiput



FIG. 416.—SEIZURE OF FOOT IN INTERNAL PODALIC VERSION (Tarnier).



is posterior and movable above the superior strait, delivery can frequently be more readily accomplished after version than by any other means. Podalic version is usually the operation of choice in prolapse of the extremities or umbilical cord, and in many cases of placenta prævia. Moreover, when the child presents some deformity, delivery is sometimes very much facilitated after version. Generally speaking, the operation is indicated in all cases requiring prompt delivery when the head is floating at the superior strait or is but slightly engaged, provided there is no great disproportion between its size and that of the pelvis. Under such circumstances it is usually a much safer procedure than the application of high forceps.



FIG. 417.—VERSION; TRANSVERSE PRESENTATION, BACK ANTERIOR, SEIZURE OF LOWER FOOT.

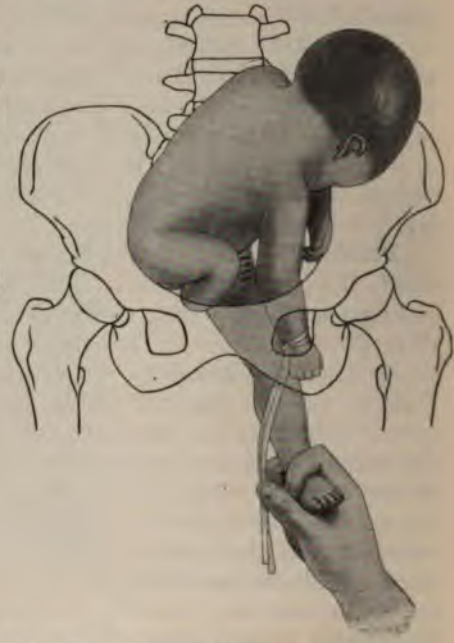


FIG. 418.—VERSION; TRANSVERSE PRESENTATION, BACK ANTERIOR, SEIZURE OF UPPER FOOT.

One of its widest fields of usefulness is after the dilatation of the cervix in *accouchement forcé*, especially in eclampsia and hæmorrhage, when version and extraction supply the readiest and most conservative method of delivery.

Marked degrees of pelvic deformity contra-indicate the operation. It is true that version can be accomplished, but afterward it is frequently impossible to extract an unmutilated child. It should never be attempted when the child is suffering from *hydrocephalus*.

The most favorable time for the performance of the operation is immediately after the rupture of the membranes, before the amniotic fluid has drained off, and while the child is readily movable in any direction.

Generally speaking, podalic version should not be attempted through an imperfectly dilated cervix, except in certain cases of placenta prævia. In many cases the patient is not seen until long after rupture of the membranes, and conditions may be present which render the operation extremely difficult or even impossible. For example, the uterus may be tetanically contracted and so tightly applied to the body of the child as to render even the introduction of the hand extremely difficult. In other cases, the contraction ring may have risen to such an extent and the lower uterine segment be so stretched as to render the operation dangerous in the highest degree, as the attempt at version will probably lead to rupture of the uterus.

*Technique.*—The patient should be anæsthetized, placed upon a table, and the usual preparations for an operation made. Version should never be undertaken without an accurate diagnosis as to the presentation and

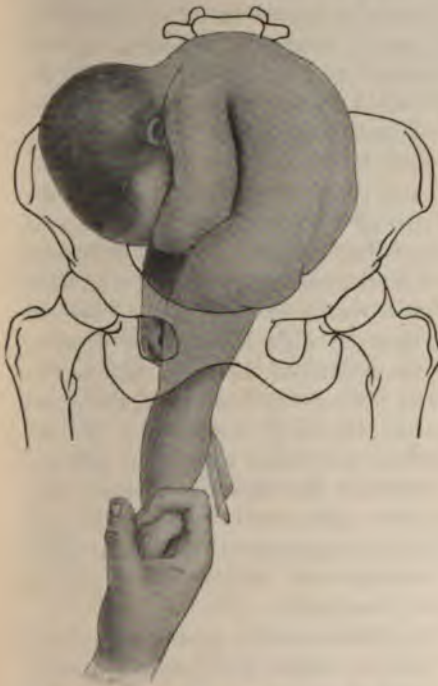


FIG. 419.—VERSION; TRANSVERSE PRESENTATION, BACK POSTERIOR, SEIZURE OF UPPER FOOT.

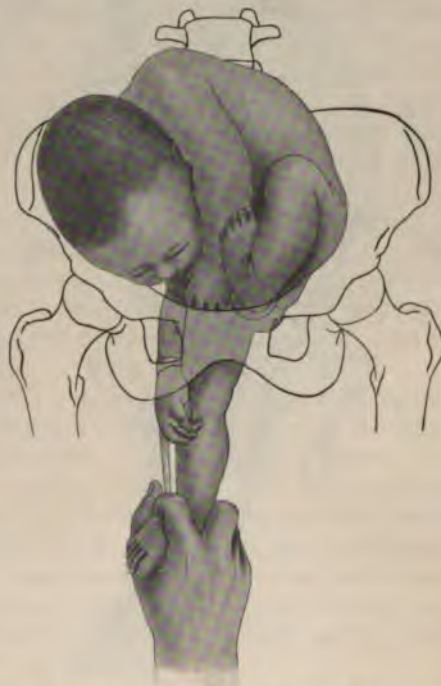


FIG. 420.—VERSION; TRANSVERSE PRESENTATION, BACK POSTERIOR, SEIZURE OF LOWER FOOT, SHOWING ARREST OF BUTTOCKS AT THE PELVIC BRIM.

position of the child. The abdomen should be covered by sterile dressings so as to allow one hand to be applied over its lower portion without becoming infected.

Podalic version may be accomplished by one of two methods—internal or combined. In the former the entire hand is introduced into the



uterus, while in the latter only two fingers are pressed through the cervix; but in both methods the other hand is applied over the abdomen and controls the movements of the fœtus.

*Internal Podalic Version.*—This should be attempted only after complete dilatation of the cervix. If the membranes are intact, they are ruptured and the hand is immediately introduced into the uterus; the feet are then seized and drawn through the cervix, the operation being usually, but not necessarily, followed by extraction. The method of procedure varies somewhat, according as one has to do primarily with a head or a transverse presentation. In the first instance, the hand and arm must be

introduced considerably farther into the genital canal than in the latter (Fig. 416).

If the child presents by the head, the choice of the hand which is to be passed into the uterus depends upon the location of the small parts. If the back be directed to the left, the feet can be seized most conveniently with the left hand, and *vice versa*. Generally speaking, it is advisable to attempt to grasp only one foot—if possible the anterior one—for when traction is made upon it the back will rotate to the front. The feet may be differentiated by tracing the course of the thigh and leg or by noting the relation of the great toe. Having found the proper foot, the ankle should be grasped between the index and second fingers, and slowly drawn through the cervix, while the external hand controls and guides the movements of the head.

In transverse presentations one foot is seized and version accomplished in the same manner. The choice of the foot, however, is a matter of very considerable importance.



FIG. 421.—BIPOLAR PODALIC VERSION (Bummi).

When the back is directed anteriorly, the lower one should be seized, as by so doing the back of the child is kept directed toward the symphysis; whereas, if the upper foot be seized, the back may turn in the opposite direction. On the other hand, when the back looks posteriorly, the upper is the foot of choice, since traction upon it will cause the back to rotate to the front; while, if the lower foot be seized, although anterior rotation will usually occur, the upper buttock is liable to impinge upon the anterior por-

tion of the pelvic brim, and great force may become necessary to effect its dislodgment (Figs. 417 to 420).

Not a few cases of transverse presentation are complicated by the prolapse of an arm into the vagina. In such circumstances, a fillet should be applied around the wrist and held loosely by an assistant, while version is performed in the usual manner. In this way the arm is prevented from becoming extended over the head, and the necessity of freeing it during extraction is obviated.

Whatever may have been the original position of the child, firm pressure should be exerted upon the fundus of the uterus as soon as extraction is begun, in order to prevent extension of the head or arms, and at the same time to facilitate delivery.

*Combined Podalic Version.*—In other instances, particularly in placenta prævia, version may be attempted by the combined or bipolar method of Hicks, as soon as the cervix is sufficiently dilated to admit two fingers. With these the presenting part is dislodged and pushed upward, while the external hand gradually brings the breech downward toward the external os. As soon as a foot can be felt it is seized by the two fingers and drawn through the cervix. For the time being this finishes the operation, as extraction should not be thought of until the cervix is fully dilated, for it can be effected only at the cost of deep cervical tears (Fig. 421).

*Prognosis.*—For the mother the prognosis following podalic version is excellent in properly selected cases, provided the patient be in good condition at the commencement of the operation. On the other hand, when attempted in the case of a tetanically contracted uterus, or when the lower uterine segment is overstretched, forcible attempts at version may lead to the rupture of the organ and death.

The prognosis for the child is fairly good, and depends upon the nature of the indication and the difficulty experienced in extraction. On the other hand, if the operation be undertaken through an imperfectly dilated cervix, and the child's head be arrested by the external os, the time required for its extraction is usually so great that death from asphyxiation is inevitable. Moreover, in cases of marked pelvic contraction, the foetal mortality is very high. In many such cases forcible traction may enable one to deliver the child, but usually not until after the cord has been so long compressed as to have caused pronounced asphyxia and death, not to mention injuries to the head resulting from pressure.

*By my dinner sent foot & rotate back to front*  
*Deliver post-remains of the breech*  
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## CHAPTER XXII

### CÆSAREAN SECTION, SYMPHYSEOTOMY, AND PUBIOTOMY

#### CÆSAREAN SECTION

In this operation the child is removed from the uterus through an incision in the abdominal and uterine walls. The origin of the term has given rise to a great deal of discussion. It has been generally asserted that Julius Cæsar was brought into the world by this means, and obtained his name from the manner in which he was delivered (*a cæso matris utero*). This explanation, however, can hardly be correct, as his mother, Julia, lived many years after her son's birth; and, besides, Julius was not the first of his name, since there is mention of a priest named Cæsar who lived several generations before. The following view, however, would appear to be more plausible. In the Roman law, as codified by Numa Pompilius, it was ordered that the operation should be performed upon women dying in the last few weeks of pregnancy. This *lex regia*, as it was called at first, under the emperors became converted into the *lex cæsarea*, and the procedure itself became known as the *Cæsarean operation*.

**History.**—The history of Cæsarean section maybe said to extend over three periods, the first lasting from the earliest times to the beginning of the sixteenth century. During this period the operation was occasionally resorted to after the death of the mother, in the hope of saving the child, but it is improbable that it was practiced upon the living woman, although several authorities are inclined to believe that certain passages in the Talmud may be so interpreted. The fact that Dr. Felkin saw a Cæsarean section performed among the natives of Uganda renders it possible that it may have been employed upon the living woman at an early period by certain of the uncivilized races.

The second period extends from the year 1500 to 1876, when Porro described his method of amputating the pregnant uterus.

According to Caspar Bauhin, the first Cæsarean section upon a living woman was performed in 1500, when Jacob Nufer, a castrator of pigs at Sigerhausen, Switzerland, operated successfully upon his own wife after she had been given up by the midwives and barbers in attendance. The fact, however, that the woman had five spontaneous labors later would go to show that this was not a true Cæsarean section, but probably the simple removal of an extra-uterine child from the abdominal cavity.

François Rousset, a contemporary of Paré, wrote a treatise upon the



subject in 1581, in which he gave the histories of a number of Cæsarean sections collected from various sources. Several of them were probably apocryphal, while others, in all probability, were operations for advanced extra-uterine pregnancy. His article, however, had the merit of directing attention to the operation and to the possibility of performing it upon the living woman. The first authentic Cæsarean section was probably done in 1610 by Trautmann, of Wittenberg. Following this, it was occasionally performed upon the living woman up to 1777, when it became temporarily eclipsed by symphysectomy, to be taken up again after the latter operation fell into disrepute.

During this period, the uterus was simply incised and the child extracted. The uterine walls were not sutured, the contraction and retraction of the organ being relied upon to check hæmorrhage. Most of the women perished from hæmorrhage or infection. Sutures were first employed by Lebas (1769), but did not come into general use until after the appearance of Säger's epoch-making article upon the subject in 1882.

Before the work of Porro and Säger, the mortality following the operation was appalling. Meyer (1867) collected 1,605 cases from the literature with a mortality of 54 per cent.; while in 80 cases performed in the United States up to 1878, collected by Harris, 52.5 per cent. of the women died. According to Budin, not a single successful Cæsarean section was performed in Paris between the years 1787 and 1876. Such poor results were obtained by physicians that Harris pointed out that the operation was more successful when performed by the patient herself, or when the abdomen was ripped open by the horn of an infuriated bull. He collected 9 such cases from the literature with 5 recoveries, and stated, that out of 11 Cæsarean sections performed in the city of New York during the same period, only one patient recovered.

The third period began with the year 1876, when Porro advised amputating the body of the uterus and stitching the cervical stump into the lower angle of the abdominal wound in order to lessen the danger from hæmorrhage and infection. This procedure, being followed by very satisfactory results, soon became quite popular, so that in 1890 Harris was able to collect 264 operations from the literature. Storer, of Boston, in 1868, performed a similar operation upon a pregnant myomatous uterus, with a fatal result, but, inasmuch as he did not appear to recognize the importance of the innovation, the credit for proposing it undoubtedly belongs to Porro.

Säger, in 1882, revolutionized the Cæsarean section by directing attention to the necessity for the employment of uterine sutures. As the uterus was not sacrificed in this operation, it was designated as the *conservative*, in contradistinction to the *Porro* Cæsarean section. With the increasing perfection of surgical technique, more and more satisfactory results were obtained from the former operation, while the latter became less popular.

After the technique for supravaginal amputation of the myomatous uterus had become more perfected, similar methods were applied to the Porro operation, the cervical stump being covered by a flap of peritoneum dropped into the abdominal cavity; while in a small number of cases,

particularly when the cervix was carcinomatous, the entire organ was removed. The latter procedure, which was first attempted by Bischoff, has but a limited field of application.

**Indications.**—The most frequent and important indication for Cæsarean section is afforded by pelves which are so contracted as to offer a serious mechanical obstacle to labor. The pelvic indication may be either *absolute* or *relative*, the upper limits being a conjugata vera of 5 and 7.5 centimeters respectively. In the former, the contraction is so pronounced that the birth of the child cannot be effected by any other means; while in the latter, it is sufficiently marked to render spontaneous labor impossible, but permits delivery after craniotomy. When the conjugata vera measures more than 7 centimeters a living, not overlarge, child may be delivered after pubiotomy.

In view of the excellent results which now follow Cæsarean section, and the fact that the spontaneous delivery of an ordinary full-term child is out of the question when the conjugata vera is less than 7.5 centimeters, the upper limit for the absolute indication has been extended to that point, provided the patient is in good condition and amid suitable surroundings for a major operation.

Even when the pelvis is less contracted, so that it falls within the so-called "border line" category—with an upper limit of 8.5 centimeters in flat and 9 centimeters in generally contracted pelves—the operation may likewise be indicated. In pelves of this character, the course of labor depends not so much upon the degree of pelvic contraction, as upon the size and consistency of the head and the character of the uterine contractions. Given two women with pelves of the same size, one may have a spontaneous and easy labor, while the other may require radical operative interference. In the latter event, the operation is undertaken primarily in the interests of the child, instead of resorting to high forceps, version, or craniotomy.

Accordingly, when examination reveals the presence of an unusually large child, or the patient presents a history of previous difficult labors with dead children, Cæsarean section should be performed at an appointed time at the end of pregnancy, or very early in labor, since the prognosis for the mother becomes more serious with every hour interference is deferred. On the other hand, if not seen until late in labor, I believe that better results for the mother, and nearly as good results for the child, will be obtained by allowing the patient to go into the second stage, and then resorting to pubiotomy if engagement does not occur after several hours of strong pains, provided, of course, the patient is in good condition, and in the hands of a competent operator. By so doing nearly all the children and many more mothers will be saved than after a late Cæsarean section. If, however, these conditions cannot be fulfilled, the patient should be allowed to continue in labor-until a definite indication for its termination arises, when craniotomy should be performed.

There is a general misconception as to the *innocuousness of craniotomy*, a somewhat general belief existing that it is unattended by maternal mortality. The results of Pinard and Bar, however, prove the contrary, as their mortality was 11.5 and 9.39 per cent. respectively. At the same



time, it must be admitted that many of their patients were infected and in bad condition when first seen, and consequently their results were infinitely worse than they would have been had all been clean cases. But when this fact has received full consideration, their figures still serve to show that the operation is not devoid of danger even when undertaken under favorable conditions.

Pelvic contraction involving the superior strait is not the only indication for Cæsarean section; in not a few cases abnormalities of the pelvic outlet likewise call for its performance. It is usually stated that a bis-ischial diameter of 7 centimeters or less is a positive indication for the operation. It will be pointed out later, however, that this does not necessarily hold good, but that such a measurement is to be regarded merely as a danger signal. It simply indicates that it will be impossible for the head to pass beneath the pubic arch, and that spontaneous labor cannot occur unless there be sufficient space between the bis-ischial diameter and the tip of the sacrum to permit the passage of the child's head. Accordingly, in such cases, the necessity for interference will depend entirely upon the length of Klien's so-called posterior sagittal diameter of the inferior strait. Other pelvic deformities which occasionally necessitate the operation will be considered in the chapters upon Contracted Pelves.

Obstruction to labor, due to conditions other than pelvic contraction, occasionally affords an indication for the operation. Thus, myomata in the lower segment of the uterus, as well as ovarian and other tumors which are prolapsed and cannot be replaced under anaesthesia, may so block the pelvic canal as to render Cæsarean section imperative. The same may be said of certain cicatricial contractions of the cervix or vagina.

Carcinoma of the cervix occasionally results in the formation of such dense and rigid tissue that dilatation becomes impossible. In such cases Cæsarean section is demanded in the interests of both the child and mother, and should be supplemented by total hysterectomy, if the disease be not too far advanced. In rare instances malignant tumors of the rectum may so obstruct the pelvic canal as to render Cæsarean section imperative. Holzapfel reported a case of this character, and Nijhoff collected the literature upon the subject up to 1905.

Halbertsma, in 1899, suggested Cæsarean section as the best method of delivery in certain cases of eclampsia complicated by an undilated and rigid cervix. Olshausen's experience also favors this view. I, however, consider that vaginal Cæsarean section is a more suitable and conservative procedure in such cases, and that the abdominal method should be employed only when the condition is complicated by a markedly contracted pelvis.

Dudley, in 1900, suggested the advisability of Cæsarean section in certain cases of placenta prævia, and Krönig and others have adopted his views. While admitting that such a procedure may be justifiable in very rare instances, I agree with Holmes that it is usually unnecessary, and, if adopted in a large series of cases, would probably not decrease the mortality of the affection.

**Contra-indications.**—Except in the presence of an absolute indication, Cæsarean section should never be performed when the child is dead or in

serious danger. It is likewise contra-indicated when the mother is infected, in poor condition, or among surroundings which render an aseptic operation impracticable. In such circumstances, craniotomy is the operation of choice, and Cæsarean section should not be undertaken unless a living child is earnestly desired; and then only after the risks incident to it have been clearly explained to a responsible member of the family. Again, the operation is usually contra-indicated when the patient has been long in labor or subjected to repeated vaginal examinations by one whose technique is questionable, even though no signs of infection are apparent at the time. If, however, the operation should be decided upon in the presence of such risks, the entire uterus should be removed after delivery of the child.

**Operative Technique.**—(a) *Conservative Cæsarean Section.*—When undertaken for the absolute, or even for the enlarged relative, indication, the operation will give almost ideal results if performed at an appointed time, a day or so prior to the end of pregnancy, or within a few hours after the onset of labor. In many cases, however, especially in hospital practice, this is out of the question, inasmuch as the patient is often not seen until she is well advanced in labor.

When the operation can be performed at a fixed time, the patient should be prepared exactly as for an ordinary abdominal operation. On the night before, after she has received a full bath, the abdomen should be shaved, disinfected, and covered with a bichloride compress. The bowels should be evacuated by an appropriate cathartic, and an enema given a few hours before she is put upon the table.

Just before the beginning of the operation, the bladder is catheterized and the abdomen redisinfected in the usual manner with permanganate of potassium, oxalic acid, bichloride of mercury, alcohol, and ether. The woman being in the dorsal position, the entire body, except the field of operation, is covered with sterile towels. In order to insure satisfactory contraction and retraction of the uterus, 40 minims of ergotole should be administered hypodermically at this time. If the patient is not seen until labor has set in, similar preparations should be made, except that the bath and the administration of a cathartic must, of course, be dispensed with.

In addition to the operator, four assistants are needed, one to give the anæsthetic, one to assist directly at the wound, and two to handle the instruments, ligatures, and sponges. With the exception of the anæsthetist, all should wear rubber gloves throughout the operation. A competent person should be charged with the reception and care of the child and receive careful instructions as to the best method of resuscitating it if necessary. The following instruments are required: 1 scalpel, 1 long blunt-pointed scissors, 2 dissecting forceps, 12 short and 6 long artery clamps, an abdominal retractor, a needle-holder and appropriate needles, as well as the usual sterile dressings, suture materials, and gauze sponges.

An incision from 16 to 18 centimeters long should be made in the linea alba about two-thirds below and one-third above the umbilicus. In this way injury to the bladder, which often extends one-third of the distance between the symphysis and umbilicus, is avoided. The abdominal walls are



usually very thin and bleed but little, rarely more than two or three clamps being required to check hæmorrhage.

The uterus will be found immediately beneath the incision. It should then be delivered through the abdominal opening, and not cut into until the edges of the latter have been clamped together posterior to the cervix, and covered with a sterile towel, so that all possibility of contaminating the abdominal cavity may be avoided.

The anterior surface of the uterus is opened longitudinally along its middle line. This is best accomplished by making an incision a few centimeters long with a scalpel, and then rapidly enlarging it with the scissors to 16 to 18 centimeters. The membranes are then ruptured, the child is seized by one foot and rapidly extracted. Two clamps are applied to the cord, which is cut between them, and the child handed to an assistant. This takes but a short time, and it is rare for more than ninety seconds to elapse between the beginning of the operation and the birth of the child. Many authorities recommend that an attempt be made to locate the position of the placenta beforehand, so that the incision may be made in such a way as to avoid it. This, however, is not necessary. If the placenta lies under the incision, it should be rapidly cut through or pushed to one side and the child extracted. This is accompanied by a slight increase of hæmorrhage, but as the operation is necessarily bloody, and as the bleeding is only momentary, it is without significance. Immediately after the delivery of the child, the uterus contracts down and hæmorrhage practically ceases. If the placenta and membranes have not become separated spontaneously, they should be peeled off and removed with the hand, care being taken that no shreds of membranes are left behind. Disinfection of the uterine cavity is not necessary. Even when the operation is undertaken before the onset of labor, it is not necessary to dilate the cervix artificially, as the canal is always sufficiently patulous to permit free drainage.

To prevent hæmorrhage, Litzmann recommended that an elastic ligature be applied about the cervix before opening the uterus. This is, however, an unnecessary precaution; nor is it devoid of danger, as the prolonged compression predisposes to uterine atony and hæmorrhage afterward. If, however, there is considerable loss of blood after the delivery of the child, the assistant should grasp the cervix firmly between his fingers and thus compress the uterine arteries. This effectually controls hæmorrhage and is preferable to the employment of a rubber ligature.

Fritsch, in 1897, proposed opening into the uterus through a *transverse incision* over the fundus, instead of by the usual method, holding that, the course of blood-vessels in that location being parallel to the incision, the hæmorrhage would therefore be less. His proposal was at once tested by many operators, and H. Schroeder has collected 94 cases so operated upon. The results were excellent, but not better than those following the more usual incision.

There would appear to be no especial advantage in adopting Fritsch's suggestion, except in the small number of cases in which it is desired to sterilize the patient by excising the tubes. On the other hand, the intestines and omentum are more liable to become adherent to the uterine wound



than with the longitudinal incision. It is urged that the fundal wound is less likely to be followed by adhesions between the uterus and the anterior abdominal wall. This is no doubt correct, but at the same time, should infection occur with the former incision, virulent material is more liable to gain access to the general peritoneal cavity; while, if it occurs with the latter, the abscess has more chance of opening through the abdominal wound.

No matter which incision has been employed, it is then closed by deep and superficial formol or chromicized catgut sutures. The former are inserted at intervals of about 1 centimeter, and extend through the entire thickness of the muscularis, avoiding the decidua. They are then tied and, if accurate approximation is not secured, the gaping margins of the wound are brought together by superficial catgut sutures which extend through the peritoneum and the upper layers of the muscularis. Recently it has been my practice to cover in all knots by means of a continuous sero-serous suture. This is readily accomplished, and is preferable to the original procedure of Sanger, in which small flaps of peritoneum were formed by excising a thin layer of muscle from either side of the wound. Any blood which may have escaped into the pelvic cavity is then carefully sponged out, and the abdominal wound closed. This is best accomplished by suturing the peritoneum, muscles, fascia, and skin in separate layers.

(b) *Porro Cæsarean Section*.—Until after the delivery of the child, the operative steps are identical in the Porro and the conservative Cæsarean section. In the former, however, as the body of the uterus is to be amputated, it is unnecessary to remove the placenta. As soon as the child is delivered an elastic ligature is tightly tied around the upper portion of the cervix. The infundibulo-pelvic ligaments are then ligated and cut through, after which the uterus is amputated a short distance above the rubber ligature. To prevent the stump from slipping backward, a long knitting needle is passed through it and allowed to rest upon the abdominal walls. The stump is then sewed into the lower angle of the abdominal wound, the remainder being closed in the usual manner. Within a short time the stump and elastic ligature slough off, leaving a depressed wound which heals by granulation. This operation is readily performed, but is rarely employed at present, because of the complicated healing necessary, and the in-drawn scar which results.

At present, when it is desirable to remove the body of the uterus, practically the same technique is employed as in an ordinary supravaginal hysterectomy with retention of the ovaries. The tubes, ovarian and round ligaments on either side are ligated a short distance from the uterus, clamped still nearer to it, and severed. With a single stroke of the scissors the broad ligament on either side is cut through down to its base. An elliptical incision is then made through the peritoneum on the anterior surface of the uterus, just above the bladder, and a peritoneal flap rapidly peeled off by means of a piece of gauze applied around the end of the finger or the handle of a scalpel. The uterine arteries are then isolated, ligated, and severed, after which the body of the uterus is amputated. The cervical stump is brought together by the necessary number of catgut sutures, cov-



ered by the peritoneal flap, and is then dropped into the pelvic cavity. The openings in the broad ligaments are closed by continuous catgut sutures, the pelvic cavity is sponged out, and the abdominal wound closed.

The operation is readily performed, and can be completed in less time than is required for an ordinary Cæsarean section; for, owing to the laxness of the pelvic floor and the abdominal walls, the upper portion of the cervix can be brought through the incision and the entire operation completed upon the surface of the abdomen.

(c) *Total Hysterectomy*.—Bischoff was the first to remove the entire uterus after Cæsarean section, and at the present time, under thoroughly aseptic conditions, the operation gives satisfactory results. The technique is identical with that employed in supravaginal amputation of the uterus, except that after the ligation of the uterine arteries the vaginal vault is cut through and the entire uterus removed, after which the opening in the vagina is closed with catgut and the broad ligament wounds are sutured. Total hysterectomy is rarely indicated except in cancer of the uterus, or in occasional cases of infection.

(d) *Extra-peritoneal Cæsarean Section*.—Frank, of Cologne, in 1907, reported 13 cases upon which he had operated by a new method, which he considers far superior to the typical Cæsarean section whenever there is any possibility of infection having occurred prior to the operation. In this procedure a transverse incision is made through the anterior abdominal wall several centimeters above the symphysis, and the peritoneum separated from the posterior surface of the bladder and the anterior surface of the lower uterine segment. After proper exposure the latter is then incised transversely and the child and placenta removed, and the wound closed. By this method the entire operation is done extraperitoneally, and, according to its inventor, may be safely employed in cases in which the conservative Cæsarean section would be contra-indicated.

The procedure was more or less modified by Latzo, Sellheim, and others, and was enthusiastically taken up in Germany. The results, however, were not as encouraging as anticipated, for Holzapfel, in 1909, reported a gross and net mortality of 8 and 5.5 per cent. in the cases collected from the literature, and Roemer, in 1911, one of 7.2 and 6 per cent. In many instances the peritoneum was torn through, thereby depriving the operation of one of its supposed advantages; while the susceptibility of the extensive connective wound to infection soon demonstrated that the operation was not adapted for employment in infected patients.

Owing to the disadvantages of supra-symphyseal extra-peritoneal Cæsarean section, Doederlein and Dührssen resuscitated the operation of *Laparotomy*, which had been recommended by Baudelocque in 1823, and rehabilitated by Gaillard Thomas in 1871, to be afterward abandoned in favor of the classical Cæsarean section. In this operation a long oblique incision parallel to Poupart's ligament gives access to the pelvic connective tissue and to the lateral aspect of the lower uterine segment, which is then opened and the child extracted by forceps. Doederlein, who reported 32 cases, states that the operation can be readily performed, but that the time required is somewhat complicated, and that drainage is always

necessary. As neither of these operations are available for use in infected patients, are more difficult to perform, and do not give better results than the classical Cæsarean section, it is questionable whether they will permanently displace it after the novelty attending their employment has disappeared.

**Choice of Operation.**—In the vast majority of cases the conservative Cæsarean section is the operation of choice, as it is readily performed and gives very satisfactory results. On the other hand, when there is any possibility of infection, complete, or at least supravaginal, hysterectomy should be done. When the uterus is the seat of tumor formation, as well as in those cases in which osteomalacia is the cause of the pelvic deformity, or in which persistent hæmorrhage resulting from uterine atony complicates the conservative operation, supravaginal hysterectomy is also the operation of choice.

In doing a Cæsarean section, the question often arises as to the advisability of *sterilizing the patient* so as to avoid the possibility of future conception. This can be effected by supravaginal amputation of the uterus, by excising the tubes, or removing the ovaries.

I consider that it is best effected by supravaginal amputation of the uterus, but with preservation of the tubes and ovaries, in order that the inconveniences attending a premature menopause may be avoided. This belief is based upon the fact that the uterus is useless if further pregnancies are out of the question, but more particularly because supravaginal amputation is safer and can be done more rapidly than the conservative operation followed by excision of the tubes or ovaries. Furthermore, the convalescence following the former operation is more satisfactory, the difference being quite as marked as that observed in the treatment of uterine myomata by supravaginal amputation or by multiple myomectomy, respectively.

It was formerly believed that sterilization could be effected by ligating the proximal end of either tube; but experience has shown that the ligatures eventually cut through or become absorbed, and that the lumen of the tube may subsequently become restored, and with it the possibility of future pregnancy. It was next suggested that the object might be accomplished by applying a double ligature to each tube and excising the portion between them; but the experiments of Fraenkel upon animals, and the experience of Zweifel, and Cripps and Williamson upon the living woman, have shown that even these measures do not insure against conception, since the ligatures may be absorbed and the cut ends of the tube become united. In order, therefore, to render a woman permanently sterile by an operation upon the tubes, they must be excised by wedge-shaped incisions at the cornua of the uterus and the wounds closed by sutures. When this is to be done, the fundal incision is preferable, as it can readily be extended to the cornua of the uterus after the extraction of the child.

Sterilization should not be attempted by the removal of the ovaries, for the reason that the retracting uterus may exert such tension upon the pedicles that the sutures may slip and fatal hæmorrhage result.

The opinion of those authorities who consider that sterilization should



form an integral part of every Cæsarean section is certainly open to question. If the patient is intelligent, the decision should be left to her or her family, but at the same time the undesirability of a one child marriage should be strongly urged; whereas with the ignorant it is incumbent upon the physician to do what he thinks is best under the circumstances. Personally, I should be unwilling to sterilize the patient at the first operation, unless she comes from a district where proper operative help might not be available in a future pregnancy. On the other hand, if she is weak-minded or diseased and is liable to become a public charge, the operation is perfectly justifiable.

**Prognosis.**—When considering the history of Cæsarean section, reference was made to the mortality attending it in former times. Since the rehabilitation of the conservative operation by Säger in 1882, and the constant advance in aseptic technique, there has been a corresponding steady improvement in the results: Caruso collected from the literature 135 operations performed between the years 1882 and 1888, with a mortality of 25.56 per cent. Since then the death rate has gradually fallen, but even at present it is not as low as many writers would have us believe, and does not average much below 10 per cent.

Thus, Routh reported a mortality of 9.7 per cent. in 1058 classical sections performed by 100 English operators who were alive on June 1, 1910; Green and Newell one of 8 per cent. in 100 operations in the Boston Lying-in Hospital, and McPherson a gross and corrected mortality of 16.15 and 4.08 per cent. respectively, in 186 operations performed in the New York Lying-in Hospital.

On the other hand, individual operators may report large series of cases with little or no mortality. Thus, Zweifel recorded 76 Cæsarean sections with 1, and Reynolds and Leopold 23 and 70 operations, respectively, with no deaths. That such results cannot be permanently maintained is shown by the results in Leopold's clinic, where a gross and corrected mortality of 6.2 and 3.3 per cent., respectively, was noted in 303 operations performed up to 1910.

No matter how good the operator, or how perfect his technique, it would appear that the mortality, even in apparently uninfected women, will depend in great part upon the period of labor at which the operation is undertaken. Reynolds analyzed 289 cases in this regard, and, upon dividing them into three groups, according as the operations were done before labor, or early or late in labor, found a mortality of 1.2, 3.8, and 12 per cent. respectively. Routh arrived at almost identical conclusions, and noted a death rate of 2.9 per cent. when the operation was performed before rupture of the membranes, 10.8 per cent. after their rupture, and 34.3 per cent. following repeated examination or previous attempts at delivery.

My own experience has been similar, so that I hold that the results following conservative Cæsarean section will approximate those obtained in ordinary gynecological laparotomies only when the operation is undertaken at an appointed time at the end of pregnancy or during the first hours of labor; whereas they become rapidly worse with each hour elapsing after rupture of the membranes. In the first period one may reckon upon

a mortality of only 1 or 2 per cent., as compared with 10 or more per cent. when the patient has been subjected to a test of the second stage of labor. For these reasons I consider that the conservative operation should be performed late in labor only when the disproportion is so great that a living child cannot be obtained by any other means, and should be replaced by pubiotomy or supravaginal hysterectomy in "border line" cases, which require interference after a test of the second stage. Finally, it should be remembered that when performed by inexperienced operators upon patients in poor condition and amid unhygienic surroundings the results will be most disastrous.

The mortality following the typical Porro operation, as well as the supravaginal amputation of the uterus with retroperitoneal treatment of the stump, likewise shows a marked decrease. Thus, the tabulation by Harris of 441 Porro operations performed between the years 1876 and 1891 showed a decrease from 60 per cent. at the beginning of the period to 22.8 per cent. at its end.

During the same period the mortality following retroperitoneal treatment of the stump was reduced from 85.7 per cent. to 16.6 per cent. In 177 operations more recently reported by Chrobak, Schauta, Leopold, and Braun the gross mortality was 10.3 per cent., which became reduced to 2.5 per cent. on deducting the cases which were infected prior to operation. On the other hand, when performed upon infected patients, no matter what method be employed, the results of the operation are still extremely unsatisfactory, Doktor, of Budapest, having collected 22 such cases, with a mortality of 23.5 per cent.

This marvelous diminution in mortality is due to several factors. Primarily, of course, it must be attributed to the ever-increasing perfection of aseptic technique. At the same time careful examination of the pelvis before labor and the determination to operate while the patient is in good condition, instead of only after the failure of other methods of delivery, have contributed markedly to the improvement.

**Repeated Cæsarean Section.**—The performance of conservative Cæsarean section does not interfere with future conception, as is shown by the fact that even in pre-antiseptic times not a few instances were reported in which the same woman had repeatedly been subjected to the operation. Nor does it affect recovery at the subsequent operation. Leopold speaks of a patient upon whom he operated four times, while Ahlfeld and Birnbaum have reported cases of women who underwent five Cæsarean sections. The statistics of Haven and Young, published in 1903, show 88 cases with 2, 26 with 3, 5 with 4, and 1 case with 5 operations; while Fröhinsholz collected 52 instances in which the operation had been performed for a third time upon the same patient.

The occurrence of pregnancy after a Cæsarean section, however, is not always devoid of danger, as Woyer, Targett, and Kerr have reported cases in which the uterine cicatrix ruptured in the latter part of the subsequent gestation. This, however, is a very unusual occurrence, Brodhead being able to collect but 20 cases from the literature up to 1908. It is also stated that the adhesions which sometimes form between the uterus and the an-



terior abdominal wall occasionally exert a deleterious influence in subsequent pregnancies. Aside, however, from the slight discomfort incident to their stretching, no serious consequences have been observed, and in not a few cases the subsequent operation has been done through the old adhesions without opening into the general peritoneal cavity.

*Vaginal Cæsarean section* has already been considered in the chapter upon *accouchement forcé*.

**Post-mortem Cæsarean Section.**—From the earliest times, when a patient died undelivered in the neighborhood of full term, Cæsarean section was sometimes performed immediately after her death, in the hope of saving the life of the child. The number of children rescued by the procedure, however, has always been very small. In view of this fact, and the abhorrence in which it is more or less justly held by the laity, I do not consider that it should be recommended, more satisfactory results being obtainable from *accouchement forcé*, especially as the cervix just before or immediately after death is more readily dilatable than at other times.

### SYMPHYSEOTOMY

By symphyseotomy is meant the division of the pubic joint in order to bring about an increase in the capacity of a contracted pelvis sufficient to permit the passage of a living child.

**History.**—J. R. Sigault first performed the operation in 1777, and thereby successfully delivered a certain Madame Suchot, of Paris, who had a rhachitic pelvis with a conjugata vera of 6.5 centimeters and had previously given birth to four dead children. The procedure created a great sensation, though when the patient was exhibited before the Faculty of Medicine two months later she walked with considerable difficulty, and had a urinary fistula from which she never recovered.

The operation was taken up with great enthusiasm, and was performed upon 11 patients within the first year after Sigault's report. Opposition to it, however, soon developed, Baudelocque denouncing it as a "murderous and unphilosophical procedure"; and the discussion as to its merits waxed so bitter that the Parisian physicians became divided into two groups, Cæsareans and Symphyseans. As a result of poor technique and its employment in unsuitable cases, symphyseotomy soon fell into disrepute and was forgotten except in Italy, where it was performed sporadically until the year 1858.

The operation was rehabilitated in 1866 by Morisani, of Naples, who obtained fairly satisfactory results by its means, being able to report 50 operations with 40 recoveries to the International Medical Congress in 1881. It was reintroduced into France by Spinelli in 1891, who impressed its merits so strongly upon Pinard that he took it up and has since been its most enthusiastic advocate, being able to report in 1900 that 100 symphyseotomies had been performed in his clinic. The anatomical aspects of symphyseotomy were carefully studied by Farabeuf, who accurately demonstrated its theoretical possibilities. Dr. Robert P. Harris played a prominent part in directing attention to the operation in this country

by a paper entitled *The Remarkable Results of Antiseptic Symphyseotomy*, read at the 1892 meeting of the American Gynecological Society. Stimulated by this report, Jewett, a few months later, performed the first operation in America, and was soon followed by many others. Since then the question of symphyseotomy has been a burning one, and was the main theme of discussion at the German Gynecological Congress in 1893, the International Medical Congress in 1897, and the Obstetrical Society of France in 1899.

**Effect of Symphyseotomy upon the Size of the Pelvis.**—As soon as the symphysis is cut through, the ends of the pubic bones gape from 3 to 6 centimeters. Owing to the structure of the sacro-iliac joints, the ossa innominata flare outward, while the tips of the pubic bones become depressed downward. As a result of these changes the capacity of the pelvic

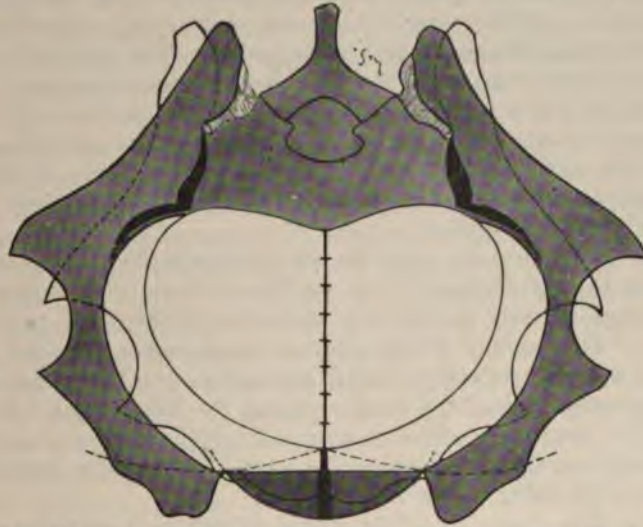


FIG. 422.—DIAGRAM SHOWING EFFECT OF SYMPHYSEOTOMY (Farabeuf).

canal becomes considerably increased, particularly in its transverse and oblique, and less so in its antero-posterior, diameters. It is usually stated that the conjugata vera becomes 2 millimeters longer for each centimeter of separation at the symphysis. As the latter may amount to 6 or 6.5 centimeters without imperiling the integrity of the sacro-iliac joints, the increase would aggregate 12 or 13 millimeters.

According to Farabeuf this estimate is not strictly correct, as the increase varies with the size of the pelvis, being 13 millimeters when the true conjugate measures 6 centimeters, and 10 millimeters when it measures 9 centimeters. This, however, does not represent the actual enlargement of the superior strait from an obstetrical point of view; for, as Farabeuf has pointed out, one of the parietal bosses fits into the opening between the gaping pubic bones, thereby considerably increasing the space available for the passage of the head. Döderlein has calculated that when the pubic



bones gape 6 to 7 centimeters the area of the superior strait is increased by one half.

**Indications.**—As the indications for symphyseotomy are identical with those of pubiotomy, they will be considered under the latter.

**Method of Operating.**—The patient should lie upon her back with the buttocks at the edge of the table, and the flexed legs held by assistants. After the external genitalia, Mons Veneris, and lower portion of the abdomen have been shaved and cleaned as carefully as for an abdominal operation, everything except the Mons Veneris and lowest portion of the abdomen should be covered with sterile towels. An incision is made in the middle line from a few centimeters above the upper margin of the symphysis almost to its lower margin, extending through the skin and subcutaneous fat down to the fascia upon its anterior surface. A finger is passed behind the symphysis, and separates the underlying tissues, until its lower margin is perfectly free. This step is frequently accompanied by profuse hæmorrhage from the antevesical plexus. The attachments of the clitoris to the lower margin of the symphysis are then separated by blunt dissection, after which a catheter is passed into the urethra and pushes it downward and to one side. The pubic cartilage is then cut through with a strong knife, either from its anterior or posterior surface. In the latter case a blunt-pointed bistoury is passed behind the symphysis and the section made from below upward.

In many cases the pubic bones do not spring apart after the symphysis has been cut through, being held in position by the strong subpubic ligament, although as soon as this has been severed they will gape several centimeters. They should not be allowed to separate more than 6 centimeters, any tendency toward excessive gaping being counteracted by having the assistants make firm pressure upon the trochanters. Following section of the symphysis, there is usually a profuse venous hæmorrhage, which is best controlled by packing the wound with sterile gauze, clamps and ligatures not being available.

After symphyseotomy, the child should be delivered by forceps or version, according to circumstances, although Zweifel and others recommend that the patient be put back to bed, and labor allowed to end spontaneously. During the extraction firm pressure should be made upon the trochanters on either side to prevent too wide a separation of the symphysis and consequent injury to the sacro-iliac joints. Owing to the fact that the anterior vaginal wall, bladder, and clitoris have been deprived of their natural support, they are exposed to considerable tension and may be torn through, notwithstanding every precaution. By adducting the thighs after delivery of the child, the ends of the pubic bones are brought together, so that the ligamentous structures upon their anterior surface can be united by mattress or figure-of-eight sutures, and the external wound is closed in the usual manner.

Ayres, in 1896, recommended that the operation be performed subcutaneously by making a small incision immediately over the clitoris through which a blunt-pointed knife is introduced, the symphysis being divided from behind forward and from below upward. Ten years later Zweifel

advocated that the section be made subcutaneously by means of a Gigli saw, just as in pubiotomy. In either event the employment of sutures is impossible.

After the completion of the operation, the wound should be covered with sterile dressings and a broad strap of canvas applied over the trochanters and tightly buckled, the latter being well padded with cotton to avoid injurious pressure. The after-treatment is complicated and onerous. Frequent catheterization is necessary, and the patient must lie on her back for three or four weeks after the operation. During this period it is well to reinforce the action of the pelvic strap by placing the patient in a hammock bed, especially devised for the purpose, or by allowing the pelvis to rest upon two sand bags.

**Prognosis.**—My experience leads me to consider that symphyseotomy performed by the open method is a very serious operation, and one not to be lightly undertaken. In many cases the hæmorrhage is exceedingly profuse, and is calculated to disconcert an inexperienced operator. Moreover, the vaginal tears frequently extend through to the retropubic wound, and are not easy to repair. Occasionally the bladder is injured by the sharp end of one of the pubic bones, while more frequently the clitoris is wounded and gives rise to alarming hæmorrhage. Such lesions should be repaired immediately, so as to avoid communication between the vagina and the pubic wound, or the formation of urinary fistulæ. Moreover, if the bones be allowed to gape too widely, serious injury may be done to the sacroiliac joints. If errors in technique have occurred during the operation, or the patient be already infected, the process may extend to the pubic wound and lead to destructive suppuration.

Considerable apprehension has been expressed as to the possibility of failure of union at the symphysis pubis, and several cases have been reported by Müllerheim which serve to show that the operation may permanently maim the patient. Fortunately, such accidents are extremely rare; although the investigations of Varnier by means of the Röntgen ray show that there is greater motility at the symphysis than before the operation, the pubic bones being united by a mass of fibrous tissue several centimeters wide. This does not necessarily lead to disturbances of locomotion, but the patients find that they tire more readily, and are less able to perform hard labor, than before the operation.

It appears that symphyseotomy is sometimes followed by a slight but permanent increase in the size of the pelvis, which is sometimes sufficient to permit spontaneous labor in subsequent pregnancies. A number of such instances have been collected by Madame Wulff. Frank and others have suggested that deliberate attempts toward permanent enlargement should be made by osteoplastic procedures.

The analysis by Neugebauer of 278 symphyseotomies indicated a maternal mortality of 11.1 per cent.; while in the 100 cases operated upon in Pinard's clinic there were 12 maternal deaths; and even after deducting a number of instances in which he considered that the fatal termination was due to other causes, the mortality was as high as 5 per cent. Bar, basing his conclusions upon 140 operations performed by himself, Pinard, Küst-



ner, and Zweifel, estimates the death rate at 6.7 per cent. The latter, in 1897, reported a series of 31 successful cases, but had 3 deaths in the following 11 operations, a mortality of 7 per cent. The foetal mortality was 13 per cent. in Pinard's, and 9.39 per cent. in Bar's cases.

Abel has compared the results obtained in 25 symphyseotomies and 50 Cæsarean sections performed in Zweifel's clinic. There were no maternal deaths in either series, but the convalescence was much more rapid and comfortable after the latter operation; and, what is more important, three to five weeks only were required before the patient was able to take up again her ordinary duties after it, as compared with thirteen weeks after symphyseotomy.

As these results became generally known the enthusiasm for symphyseotomy gradually disappeared, and most obstetricians came to regard Cæsarean section as a safer and more satisfactory operation. The extent of the reaction may be realized from the statement of Kehrer, that in 1905 Zweifel, Frank, and Baumm were the only well-known German obstetricians who continued to employ the operation.

During the past few years a number of writers have rehabilitated the subcutaneous method of operating, and by limiting its employment to suitable cases have obtained results comparable to those following pubiotomy. Thus Frank, in 1910, reported 60 such cases with only a single death.

### PUBIOTOMY

This operation, which is more properly designated as hebotomy or heboosteotomy (from *τὸ τῆς ἡβῆς ὀσσοῦν*), consists in obtaining a temporary enlargement of the pelvis by severing the pubic bone to one side of the symphysis by means of a Gigli saw.

**History.**—In 1893 Gigli stated that from a surgical point of view there were two serious fallacies in the operation of symphyseotomy. In the first place, the wound through the cartilage was very prone to infection, and healed but slowly, and, secondly, the incision in the mid-line deprived the urethra and bladder of their natural support, and thus exposed them to serious injury during the delivery of the child. To overcome these difficulties, he proposed that the incision be made through the pubic bone itself, as he held that the bone wound would heal more rapidly and be less liable to infection, while its lateral position would avoid interference with the attachments of the urethra and bladder, and thus reduce to a minimum the possibility of their injury. In order to sever the bone he invented the flexible wire saw, which is generally known to surgeons by his name.

Gigli did not perform the operation until April, 1902, but his suggestion was put into practice by Bonard, of Lugano, in 1897, who was followed by Calderini and Van der Velde in 1899 and 1901, respectively. Following the report of the latter, the operation was rapidly taken up and modified, so that three methods are now available.

**Technique.**—Originally, the anterior surface of the bone was exposed by an oblique incision, beginning slightly above the inner margin of the pubic spine and extending to the middle of the outer part of the labium majus.

Then by means of a pair of artery forceps the saw was adjusted to the posterior surface of the bone, which was then severed. In 1904 Döderlein modified the operation and, instead of a large open wound, made a small incision, just large enough to admit a finger, parallel to and somewhat above the pubic bone. After separating the periosteum, a curved instrument, somewhat like a large aneurism needle, was passed behind the bone and pushed through the labium majus. The saw was then fastened to the lower end of the instrument, and brought into position by withdrawing it. In 1906 Stoeckel and Kannegieser reported that their respective chiefs, Bumm and Leopold, had performed the operation entirely subcutaneously. For this purpose the instrument was thrust through the upper end of the labium majus, and, under the guidance of a finger in the vagina, carried up along the posterior surface of the pubic bone and brought out through the skin above its upper margin, between the pubic spine and the symphysis pubis, the saw being adjusted by withdrawing the instrument from above downward.

Up to January, 1912, my assistants or myself have performed 38 successful pubiotomies upon 36 patients, two women having been operated upon twice. As Döderlein's method was employed in all but the first case, and has proved most satisfactory, I shall describe its technique in some detail.

After emptying the bladder and rectum and shaving the lower abdomen and pubic region, the patient is brought to the edge of the table, and prepared for operation in the usual manner. The legs are held by assistants. An incision extending  $2\frac{1}{2}$  centimeters inward from the pubic spine is then made just above the upper margin of the pubic bone, and the tissues cut through down to it. After incising the periosteum, a finger is passed into the wound and separates the tissues from the posterior surface of the bone. Then a large pair of curved artery forceps, or an especially constructed needle, is carried down along the posterior surface of the bone until its inferior margin is reached, when its handle is depressed in such a manner that its tip can be felt through the upper and outer part of the labium majus. A small incision is made over the projection, through which the tip of the instrument is pushed. To it one end of the saw is attached, and is drawn into position as the instrument is withdrawn through the up-



FIG. 423.—SHOWING INCISIONS FOR PUBIOTOMY.



per wound. The handles are then attached to the saw and a few movements suffice to sever the bone. Care should be taken that the bone is severed in the desired direction, and the movements continued until the saw moves freely beneath the skin.

In many cases the ends of the bone gape for 2 or 3 centimeters as soon as the section is complete; but, when all the ligamentary structures have not been divided, this does not occur until traction is made upon the child. Upon withdrawing the saw, blood gushes freely from both wounds,

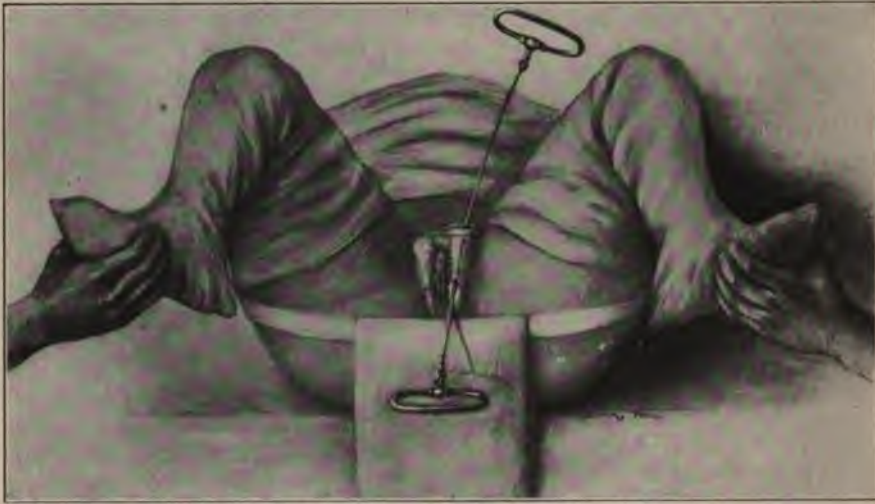


FIG. 424.—SHOWING POSITION OF PATIENT AND GIGLI SAW.

but in all of my cases the hæmorrhage was readily controlled by firm pressure with gauze sponges. As soon as it is checked, the child should be delivered by forceps or version, as is most convenient, as I can see no advantage in waiting for its spontaneous expulsion, as recommended by Döderlein and Zweifel. As traction is made, the ends of the bone will gape more widely, but a separation of more than 5 or 6 centimeters should be avoided by having the assistants make firm pressure upon the thighs. While waiting for separation of the placenta, a small drain should be brought through the opening in the labium majus, and the upper wound sutured.

After labor the patient is cleaned up, a sterile dressing applied over the upper wound, and a long strip of adhesive plaster six inches wide passed around the body so as to make firm and equal pressure over the sides of the pelvis and upper part of the thighs. This is not essential, as many German operators do not attempt to immobilize the pelvis. The patient is then put to bed, and, for convenience in handling, placed upon a Bradford frame, upon which she begins to move freely on the second or third day. She is not catheterized unless necessary, and is kept in bed for fourteen days, being allowed to try to walk on the second day after getting up. The power of locomotion soon returns, and all of my patients have felt able to leave the hospital before the end of the fourth week.

I have had no experience with the purely subcutaneous operation, but Roemer states that it is followed by injuries to the bladder twice as frequently as when Döderlein's technique is employed, so that it would seem that the possibility of injuring the bladder is somewhat lessened by separating the tissues posterior to the bone with the fingers.

Healing of the bone wound occurs more frequently by fibrous than by bony union, being noted in all of my patients. If the latter has not become established within the first few weeks following the operation, it will not occur at all. This, however, has no effect upon locomotion, as all of my patients, upon reëxamination some months later, stated that they were able to walk as well and work as hard as previously. Moreover, the occurrence of fibrous union should be regarded rather as a favorable outcome, for the reason that it sometimes leads to a slight enlargement of the pelvic diameters, which may be still further accentuated in a subsequent pregnancy by the softening and relaxation incident to the increased hyperæmia attending that condition. Occasionally this may be sufficient to permit spontaneous labor, which occurred in several of my patients, although the children were several hundred grams heavier than those which previously necessitated pubiotomy. Such an outcome, however, cannot always be expected, yet it occurs sufficiently frequently to permit it being urged as an argument in favor of the operation. This is especially the case in funnel pelvis, and in two of my patients the distance between the tubers became enlarged to such an extent as to overcome the deformity permanently, and thus permit subsequent spontaneous labors.

**Prognosis.**—Maier, in 1907, and Schläfli, in 1909, collected 267 and 700 operations from the literature with a mortality of 5.6 and 4.82 per cent., respectively. I do not consider that such figures correctly represent the real dangers of the operation, as Schläfli's statistics are based upon the results of 142 operators, many of whom had little experience, and naturally could not be expected to obtain the best results. On the other hand, Döderlein states that in 321 pubiotomies performed in 7 German clinics up to 1910, the mortality was 1.8 per cent., and my own experience and study indicate that it should not exceed 1 or 2 per cent. This is comparable to the results following early elective Cæsarean section, and far superior to those obtained when it is performed after a test of the second stage of labor.

Usually the hæmorrhage, which may be quite profuse, is venous in character, and is readily controlled by pressure; but occasionally aberrant branches of the internal pudic artery may be cut, when it may become necessary to lay the entire wound open to ligate the bleeding vessel. Very exceptionally, even this is not possible, and one of Rosthorn's patients died from uncontrollable hæmorrhage.

Moreover, deep vaginal tears occasionally occur during the extraction of the child, and require immediate repair; while less frequently the bladder or urethra is injured, either by being perforated by the sharp ends of the bone, or as the result of traction. If proper care is taken in dilating the birth canal with hand before beginning the operation, by making horizontal instead of upward traction when delivering the head, and by avoiding undue violence, the occurrence of such accidents can be minimized. In



only one of my cases was the bladder injured, and in only a few was the vagina torn, notwithstanding the fact that more than one half of the patients were primiparæ.

Convalescence in general is very satisfactory, and the patients complain of but little pain or discomfort. In nearly one half of the cases the puerperium is somewhat febrile, but only one of my patients was seriously ill. In many instances there is considerable œdema about the vulva, and occasionally hæmatomata of considerable size develop. Moreover, several writers believe that the operation considerably increases the liability to femoral phlebitis.

**Indications.**—Pubiotomy is performed solely in the interests of the child, and is contraindicated when it is dead or the conjugata vera measures 7 centimeters or less. Accordingly, it scarcely enters into competition with Cæsarean section, except for the broadened relative indication. As far as my experience justifies conclusions, I feel that one may look forward to pubiotomy practically displacing Cæsarean section in the so-called "border-line" cases, when several hours of second-stage pains have demonstrated that the head cannot pass the superior strait. Pubiotomy can be safely performed under such circumstances, while the prognosis for Cæsarean section becomes progressively worse the later in labor it is performed. On the other hand, if one feels reasonably sure, either from the size of the child or the history of the previous labors, that interference will be necessary, I consider that the patient should not be subjected to the test of labor, but that Cæsarean section should be done at an appointed time before its onset.

I hold that pubiotomy will still further narrow the field for the induction of premature labor, and practically do away with the use of high forceps, version, or craniotomy in moderate degrees of contracted pelvis when the mother is in good condition. It is especially indicated in certain cases of funnel-shaped pelvis, as well as in face presentations when the chin has rotated into the hollow of the sacrum.

I do not believe that the operation should be undertaken when signs of infection are present, as the interests of the mother will be better served by craniotomy or Cæsarean section followed by the removal of the uterus. For the present, at least, I feel that the employment of pubiotomy should be limited to well-equipped hospitals or the practice of experts, since several well-trained assistants are necessary to its proper performance, and, moreover, serious complications may occur at any time, which will seriously tax the resources of even a competent surgeon.

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## CHAPTER XXIII

### DESTRUCTIVE OPERATIONS

#### CRANIOTOMY

Under this heading are included all operations which bring about a decrease in the size of the foetal head, with a view to rendering its delivery easier.

Prior to the introduction of podalic version and forceps, artificial delivery could be effected only by means of craniotomy or embryotomy, one or other of which was resorted to in nearly every case of difficult labor. Accordingly, in former times, the perforator, sharp hook, and crotchet were the most important instruments in the obstetrician's armamentarium. Increased dexterity in the employment of forceps and version, however, brought about a rapid change, and craniotomy upon the living child became rarer and rarer.

**Indications.**—Craniotomy is positively contra-indicated when the conjugata vera measures less than 5.5 centimeters, since in such cases the extraction of the child, even after the skull has been crushed, is attended by a greater maternal mortality than Cæsarean section. On the other hand, in pelves above this limit, craniotomy may be indicated under any conditions that render the delivery of a mutilated child the most conservative procedure, so far as the safety of the mother is concerned.

The indications for its performance vary markedly. When the child is dead craniotomy is always indicated, unless the disproportion between the head and the pelvis is so slight that delivery by forceps or version can be accomplished without detriment to the mother. *Æsthetic* considerations should never deter the operator from resorting to it. On the other hand, if the child is alive, the operation is justifiable only in exceptional cases; indeed, Pinard and some others go so far as to hold that, in view of the satisfactory results obtained from pubiotomy and Cæsarean section, it should never be performed. This, however, must be looked upon as too radical a view; for, although it must ever be the duty of the obstetrician to do his best to save the life of both mother and child, it is nevertheless readily conceivable that conditions may arise under which craniotomy upon the living child may not only be perfectly justifiable, but even imperatively demanded.

Generally speaking, craniotomy should not be performed upon the living child if the mother is in good condition, amid suitable surroundings, and in the hands of a competent operator. Under such circumstances, if the

obstacle to labor be due to a contracted pelvis or a large child, Cæsarean section or, in certain cases, pubiotomy is preferable, inasmuch as the slightly increased risk to the mother is more than compensated for by the rescue of her offspring. On the other hand, if the woman is not seen until she has been in the second stage of labor for a considerable time, and has been subjected to repeated vaginal examinations, Cæsarean section is clearly contra-indicated, as is also pubiotomy if signs of infection be present. In such cases the child should be sacrificed in the interests of the mother. Again, if the child is not in good condition, as shown by a too rapid or too slow heart-beat, or by the passage of considerable quantities of meconium with a vertex presentation, its life is already in such peril that, against that of the mother, it is no longer entitled to serious consideration.

Moreover, in country districts, where the physician is unable to summon sufficient assistance, and is without the necessary appliances for an aseptic operation, Cæsarean section or pubiotomy should not be undertaken, and craniotomy becomes the operation of choice. But even under these adverse conditions, the destructive operation should be deferred as long as possible, and should not be resorted to until delivery becomes imperative in the interests of the mother, and then only after the failure of forceps.

If, however, such a patient should again become pregnant, she should be sent to a city where proper treatment can be obtained, as I consider that a physician who repeatedly performs craniotomy upon the same patient is but little better than a professional abortionist.

Hydrocephalus affords a positive indication for craniotomy, which should be performed as soon as the cervix is completely dilated. In many instances extraction will not be necessary, as the mere evacuation of the fluid may be followed by the spontaneous extrusion of the child. In this condition a destructive operation is the more readily undertaken, as even a successful Cæsarean section will only give us a child that is doomed to die shortly or remain an idiot.

When insuperable obstacles are encountered during the extraction of the after-coming head, craniotomy is a justifiable procedure, since the child is already dead, or dies within a few minutes after the nature of the obstacle has been recognized, and before preparations can be made for its delivery by pubiotomy.

Craniotomy should not be performed until the external os has become completely dilated, as the imperfectly opened canal may offer a serious obstacle to the extraction of the child.

**Method of Operating.**—The patient should be brought to the edge of the bed or table, placed in the lithotomy position, and prepared as for an ordinary obstetrical operation. Craniotomy usually includes two steps; first, the perforation of the head and evacuation of its contents; and, secondly, the extraction of the mutilated child.



FIG. 425.—SMELLIE'S SCISSORS.

Numerous instruments have been devised for perforating the head, the most suitable of which are *Smellie's scissors* or *Blot's perforator*. Braun's



trepan would serve the purpose admirably, but is not to be recommended on account of the difficulty with which it is kept clean.

If the head is engaged and firmly fixed, perforation is accomplished with but little difficulty. With two fingers the large or small fontanelle, as may be most convenient, is located, and the perforator plunged through it. The opening is then enlarged and the instrument briskly moved about

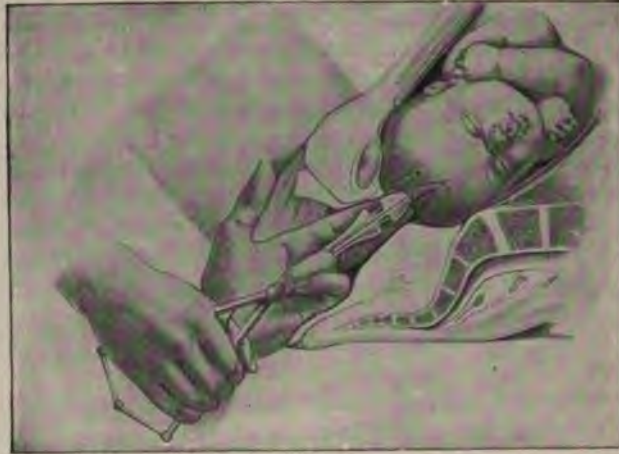


FIG. 426.—METHOD OF PERFORATING HEAD (American Text-Book).

within the skull so as to disintegrate the brain to such an extent that it can be washed out with a douche of sterile water.

If, however, the head is movable above the superior strait, it must be firmly fixed by means of pressure exerted by an assistant through the abdominal walls. To avoid wounding the maternal soft parts, the perforation should be made through the portion of the head lying in the neighborhood of the symphysis pubis; for, should the instrument slip from this position, it is less liable to inflict serious injury than if it were near the sacrum. In face presentations perforation should be effected through the brow.

To pierce the after-coming head, the body of the child should be depressed, and the instrument carried into the skull in the neighborhood of the temporal suture. If, as occasionally happens, this point cannot be reached, the body of the child should be carried up over the abdomen of the mother, and perforation effected through the mouth and base of the skull. When a hydrocephalic child presents by the breech, and the head is arrested at the pelvic brim, the fluid contents of the skull may be evacuated by cutting through the arch of one of the cervical vertebræ, after which a metallic catheter is passed through the opening and carried along the vertebral canal into the skull.

After the brain has been washed out, although the vault of the cranium collapses and offers no further obstacle to labor, the base of the skull still remains unchanged and, as the bimastroid diameter measures between 7 and

7.5 centimeters, it is obvious that it cannot be delivered through a markedly contracted pelvis until it has been diminished in size.

When the conjugata vera exceeds that limit, the collapsed head may be expelled by the uterine contractions alone, or may be extracted by means



FIG. 427.—BRAUN'S CRANIOCLAST.

of the forceps or a finger introduced through the perforation opening. But even in pelves of this size it is usually advisable to make use of a special instrument for grasping and crushing the base of the skull. The *cranioclast*, invented by Simpson and modified by Carl Braun, serves the purpose most satisfactorily.

One blade is introduced through the perforation until its free end impinges upon the base of the skull, while the fenestrated blade is applied over the face or lower portion of the occiput. The vise at the end of the instrument is then tightened, and as a result not only is the base of the skull more or less compressed, but at the same time a firm hold is obtained for the extraction that is to follow.

For crushing and extracting the head Baudelocque the younger invented the *cephalotribe*. This is essentially a very heavy forceps, whose blades come closely together and forcibly compress the head, when the vise at the ends of the handles is tightened. The instrument has been subjected to many modifications,

the best being those of Tarnier and Braxton Hicks. At the same time it labors under the disadvantage that it aims to accomplish two purposes—i. e., crushing and extracting the head; and, unfortunately, whenever it is

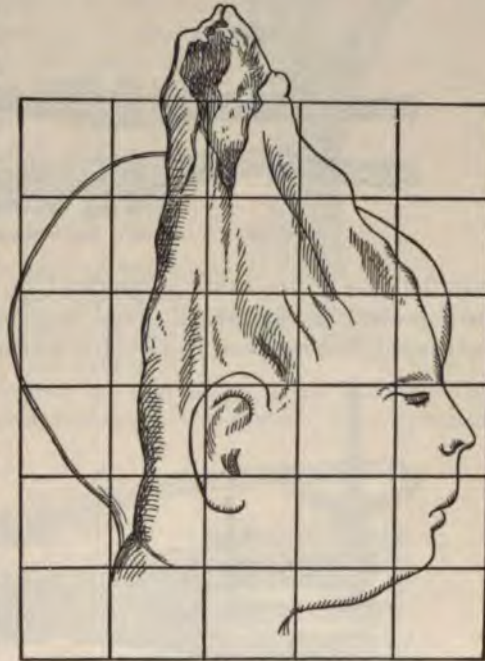


FIG. 428.—HEAD CRUSHED BY CRANIOCLAST (Simpson).



so constructed as to be an efficient crusher it is a poor tractor, and *vice versa*. For these reasons the cephalotribe, as such, is but little used.

Tarnier, in 1883, invented the *basiotribe*, a three-bladed instrument which combines in one the advantages of the perforator, cranioclast, and



FIG. 429.—TARNIER'S CEPHALOTRIBE.

cephalotribe. One blade is spear-pointed, and after serving as a perforator is forced into the base of the skull. The second blade is then introduced over the occiput and the third over the face of the child. All three are articulated, and the vise at the handles is screwed down, with the result



FIG. 430.—TARNIER'S BASIOTRIBE, DISARTICULATED.

that the base of the skull is fractured in many directions, and the head is compressed into an elongated and shapeless mass. This is a most efficient instrument, and has been particularly recommended by Pinard and Bar.



FIG. 431.—TARNIER'S BASIOTRIBE.

Sir A. R. Simpson, of Edinburgh, devised an instrument known as the *basilyst-tractor*, which likewise consists of three blades. The tips of two of them come together and form a screw-like instrument. This first perforates the skull, and by a rotatory motion is then worked into the base, which is

fractured in many directions by separating the two blades by pressure upon the handles. After this the third blade is introduced over the face or occiput and screwed tightly in place, thus converting the instrument into a typical cranioclast (Figs. 433 and 434). The basilyst-tractor gives very satisfactory results, and according to its inventor will compress the base of the skull into a mass 3.5 centimeters in diameter.

When perforating a hydrocephalic child, it is important to remember that the brain is spread out over the interior of the skull as a layer of tissue only a few millimeters thick. When this is perforated, the fluid filling the dilated ventricles of the brain escapes and the skull collapses, after which delivery is readily effected. Occasionally perforation does not result in the death of the child, which will cry after its birth. In order to guard against this most distressing occurrence, the obstetrician should not be content with merely perforating the skull at one point, but should carry the instrument back to the base of the brain and stir it around so as to destroy effectually the upper portion of the medulla, Pernice having reported the case of an infant who survived craniotomy and grew up an idiot.

**Prognosis.**—In moderate degrees of pelvic contraction, craniotomy, if properly performed in uninfected women, is almost devoid of danger. On the other hand, when the conjugata vera measures 5.5 centimeters or less, the mortality exceeds that following Cæsarean section. It must be remembered, however, that, if the operation



FIG. 432.—EFFECT OF BASIO-TRIBE.



FIG. 433.—SIMPSON'S BASILYST, DISARTICULATED.

be deferred until infection has occurred, it is a serious procedure, and is attended by a considerable mortality.



## EMBRYOTOMY

In embryotomy the viscera are removed through an opening in the thorax or abdomen of the child, or the head is severed from the body. The former operation is known as evisceration, the latter as decapitation.

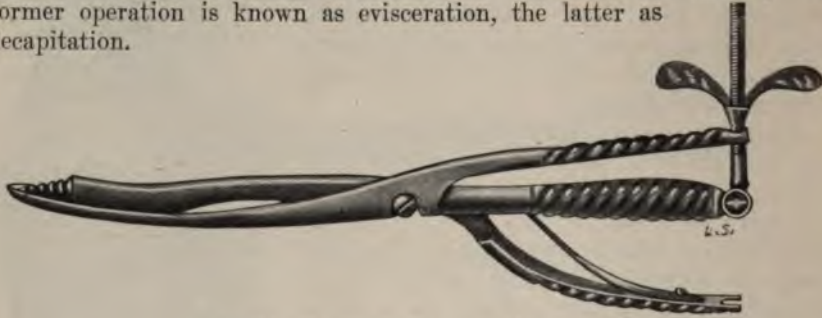


FIG. 434.—SIMPSON'S BASILYST, ARTICULATED.

At present *evisceration* is rarely employed, though it occasionally becomes necessary in order to effect the delivery of certain monstrosities, or children suffering from unusual enlargement of the thoracic or abdominal cavities, resulting from tumor formation or the accumulation of fluid. It may likewise become necessary in rare cases of transverse presentation, when the thorax or abdomen of the child lies over the superior strait and the neck is not accessible. In such circumstances an opening is made by scissors through the thoracic or abdominal wall, as the case may be, sufficiently large to admit two fingers, with which the viscera are then torn loose from their attachments and slowly extracted.

*Decapitation* is much more frequently employed, and is indicated more particularly in *neglected transverse presentations*. As a rule, when seen early, such cases can be readily delivered by version and extraction; but exceptionally the condition is overlooked, and assistance is not called for until one shoulder has become firmly impacted in the pelvic canal, the lower uterine segment at the same time being so stretched as to make an

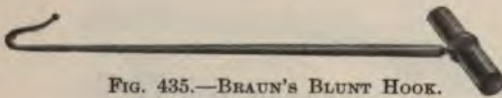


FIG. 435.—BRAUN'S BLUNT HOOK.

attempt at version practically synonymous with rupture of the uterus. Under such circumstances the child can be delivered only by Cæsarean

section or decapitation. The former may be indicated if the fetal heart sounds are strong, the mother in good condition and earnestly desirous of a living child; while the latter is urgently indicated if the child is dead, and generally speaking is the operation in most neglected cases. It can readily be accomplished by means of Braun's blunt hook or of John Ramsbotham's sickle knife, which is extensively used in England.

Fortunately, in neglected shoulder presentations, decapitation is usually materially facilitated by the prolapse into the vagina of one arm. This having been seized and brought through the vulva, firm traction should

be exerted upon it so as to put the neck on the stretch as much as possible. The index finger of one hand is then passed over the neck and used as a guide in applying Braun's hook as accurately as possible. When in position, the tip of the instrument is covered by the finger so as to avoid wounding the maternal soft parts. All being in readiness, strong traction is now made upon the handle of the instrument, which at the same time is given a rotary movement, by which the cervical vertebræ are disarticulated, and on continuation of the motion the neck is readily severed from the body. If any resistance is offered by the skin, it may be cut with scissors. After decapitation the body is extracted by traction upon the arm; or, if that be not available, by version. The head can frequently be expressed from the uterus by manœuvres similar to those employed for the delivery of the placenta, but if these prove unsuccessful a finger is introduced into the uterus and inserted into the mouth of the child, after which, as a rule, extraction is readily effected by traction upon the lower jaw. If this is not effectual, delivery can be accomplished by means of a cephalotribe or after perforation.

Zweifel believes that decapitation can be rendered easier by the use of the *trachelorhekte*, which consists essentially of a double Braun's hook. So far as my own experience goes, I see no necessity for the new instrument, as I have always been able to effect decapi-



FIG. 436.—DECAPITATION WITH BRAUN'S BLUNT HOOK (American Text-Book).



Fig. 437.



Fig. 438.

FIGS. 437, 438.—SHOWING MODE OF ACTION OF BLUNT HOOK (American Text-Book).



tation by means of Braun's hook. Again, if the latter be not available, the operation may be performed by means of a pair of long curved scissors, similar to the embryotomy scissors of Hodge.

Occasionally, in head presentations, the excessive size of the shoulders may prove a serious obstacle to labor. In such cases *cleidotomy*, proposed by Von Herff and Strassmann, renders excellent service. In this operation a pair of long curved scissors are introduced under the guidance of the hand and cut through the clavicles on either side, after which the shoulder girdle collapses and delivery is readily effected.

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## CHAPTER XXIV

### OPERATIVE PROCEDURES WHICH DO NOT AIM AT DELIVERY

In this chapter will be considered a number of procedures usually designated as minor operations, which may become necessary during pregnancy, labor, or the puerperium.

**The Douche.**—We distinguish between vaginal and uterine douches, according as a considerable quantity of fluid is injected into the vaginal canal alone or directly into the uterine cavity.

*Vaginal Douche.*—Following the introduction of antiseptic methods into obstetrics, the use of an antiseptic, *prophylactic vaginal douche* became a routine part of the conduct of labor, in the belief that by its means the countless pathogenic micro-organisms supposed to exist in the vaginal secretion of pregnant women could be destroyed, or at least rendered innocuous, and the risk of auto-infection minimized. Experimental work, however, has shown clearly that, with the exception of the gonococcus, the vaginal secretion during pregnancy rarely, if ever, harbors pyogenic bacteria, and that the prophylactic vaginal douche is unnecessary. Furthermore, clinical experience has demonstrated that it is not only useless but even directly harmful, as its routine employment is followed by a greater number of febrile cases during the puerperium than when it is omitted. This question will be dealt with more fully in the chapter upon puerperal infection.

Accordingly, at the present time the vaginal douche is employed only exceptionally during pregnancy and labor; as, for instance, when the pregnant woman presents a profuse vaginal discharge due to gonorrhœal infection. In such cases four liters of a hot 1 to 10,000 bichloride solution may be injected into the vagina twice daily during the last few weeks of pregnancy, not so much in the hope of curing the disease as avoiding infection of the child's eyes during labor. This is all that can reasonably be expected, inasmuch as the gonococci have usually invaded the glands of the cervical canal, where they are protected from the action of the antiseptic fluid.

Many authorities recommend the employment of a prophylactic vaginal douche if the patient has been subjected to repeated examinations during labor by persons who habitually neglect ordinary aseptic precautions, and particularly if signs of infection are present. Owing to the impossibility of thoroughly disinfecting the vagina at that time, the value of such a procedure is questionable; but a douche consisting of several liters of hot sterile salt solution can do no harm.



After the first week of the puerperium, the vaginal douche is frequently employed when the lochia present an offensive odor. It need hardly be said, however, that it is of but little value as a disinfectant, but merely removes mechanically the secretion collected in the vagina, and thus adds materially to the comfort of the patient. Sterile salt solution or a 2½-per-cent. solution of carbolic acid, either alone or combined with boric acid and a little oil of peppermint, may be employed.

Occasionally, when a puerperal infection has become localized, and has given rise to induration at the base of the broad ligament or in Douglas's *cul-de-sac*, the application of heat by means of abundant douches of a hot fluid markedly alleviates suffering, hastens the maturation of the abscess, and prepares the way for its prompt evacuation.

Before giving a vaginal douche, the external genitalia should be carefully cleansed and the patient placed upon a douche pan as she lies in bed, or brought to the edge of the bed and placed in the obstetrical position with a rubber pad beneath her. A fountain syringe, containing four quarts and provided with an appropriately shaped glass nozzle, previously sterilized by boiling, is employed, and the fluid allowed to run in under moderate gravity pressure. For the first ten days of the puerperium rigid aseptic precau-



FIG. 439.—GLASS DOUCHE TUBE.

tions should be observed in the use of the douche, and its administration should not be intrusted to the nurse, unless one is assured of her competency.

*Intra-uterine Douche.*—The intra-uterine douche is not employed so long as the uterine cavity is occupied by the product of conception, but is frequently used immediately after labor and during the puerperium.

Formerly it was customary to give an intra-uterine douche after all obstetrical operations. Such a procedure, however, is indicated only when the patient has exhibited signs of infection during labor; in these cases an intra-uterine douche of several liters of hot salt solution given after the completion of the third stage does no harm and occasionally is productive of good.

The most usual indication for its employment immediately after labor is afforded by *post-partum hæmorrhage* due to atony of the uterus. In such cases the administration of a douche of 4 or 5 liters of hot sterile salt solution will usually lead to efficient and permanent contraction, provided that fragments of the placenta are not retained *in utero*.

The intra-uterine douche is also frequently employed during the puerperium, especially in the presence of *infection*. It has, however, been greatly abused; for, while it must be admitted that it is frequently a most valuable therapeutic agent, it is nevertheless true that it may be directly harmful. For these reasons great care should be taken in the selection of the cases in which it is employed. Generally speaking, it is contra-indicated in all cases of streptococcic infection, inasmuch as the necessary manipulations may give rise to an extension of the process. On the other

hand, when the symptoms are due to infection by the so-called putrefactive organisms, associated with retention of the lochial discharge, the introduction into the uterus of several liters of hot salt solution is frequently followed by an immediate fall of temperature and a permanent improvement in the condition of the patient. Usually a single douche brings about the desired result, though occasionally its repetition may be necessary.

Sterile salt solution should be employed for intra-uterine douching, instead of the antiseptic solutions which were formerly recommended; since the latter, no matter how strong they may be made, can act only in a purely mechanical way, and cannot destroy the bacteria which have already invaded the endometrium. On the other hand, their use occasionally causes the death of the patient, particularly when bichloride of mercury is employed. On looking over the literature upon the subject some years ago, I collected over 40 cases in which death from mercurial poisoning followed the use of such solutions for intra-uterine injection.

Inasmuch as the administration of an intra-uterine douche must always be regarded as a serious matter, it should be given by the physician himself and not delegated to the nurse, no matter how competent she may be; since the most rigid aseptic precautions are necessary, and failure in this regard may result in infection of the patient. As a preliminary, the vagina should be douched out. Two fingers having then been employed to locate the external os, the douche-tube is passed through it until it impinges upon the fundus of the uterus. Four or five liters of fluid are then slowly injected, care being taken to insure a free return flow.

During the puerperium the cervical canal rapidly diminishes in caliber, and, owing to the marked ante flexion of the uterus which frequently occurs in this period, may become so bent as to offer a considerable obstacle to the introduction of the nozzle. To overcome this difficulty, traction should be made upon the anterior lip of the cervix by means of a pair of bullet forceps, when the cervical canal becomes straightened out. Occasionally, the contraction ring offers an obstacle, and the nozzle is arrested in the collapsed lower uterine segment. By making traction upon the cervix, and cautiously moving the extremity of the douche-tube, it can usually be passed into the uterine cavity without further difficulty.

**Curettage.**—By this term is understood the removal of the lining membrane of the uterus by means of a curette. The operation may be indicated in three conditions: incomplete abortion, imperfect involution of the puerperal uterus, and certain cases of infection.

When portions of the placenta and membranes are retained within the uterus after an *incomplete abortion*, many authorities recommend their removal by means of a dull curette. As a preliminary, the cervix, if not sufficiently pervious, must be dilated by a suitable instrument, preferably that of Goodell or Hegar (see Fig. 337). The blunt curette is then introduced into the uterus and gently scrapes off the retained structures. The employment of an instrument, however, is rarely advisable, as it is far better to peel off the adherent placenta and membranes with one or two fingers, whose movements are controlled by the other hand, through



the abdominal walls. After they are once loosened, the retained structures can be readily removed by means of the fingers or an ovum or placental forceps. The former procedure necessitates the introduction of the entire hand into the vagina, and can only be accomplished under anæsthesia.



FIG. 440.—CURETTE.

After the uterus has been emptied in such cases, the fingers are again introduced and carefully palpate its cavity, in order to make sure that the offending structures have been entirely removed and thereby to avert all danger of subsequent hæmorrhage. If the curette is used, considerable portions of placenta may be left behind, which may later give rise to bleeding and necessitate another operation. On several occasions I have seen cases in consultation in which hæmorrhage had persisted after curettage, and on examination found that considerable portions of the placenta, or even the entire ovum, had been left in the uterus, the physician having removed only a part of the decidua at the previous operation. Moreover, curettage always carries with it the possibility of perforating the uterus, the walls in many cases being so soft and friable that the accident may occur despite the exercise of the utmost caution. Fortunately, the injury is generally attended by but little danger, although, if the uterine contents be infected, it may give rise to fatal peritonitis; again, in rare cases, a loop of gut may prolapse through the rent in the uterus and necessitate a major operation.

Probably the most justifiable indication for curettage in obstetrical practice is the loss of blood during the latter part of the puerperium, resulting from *imperfect involution of the uterus*, which is frequently associated with the retention of portions of the placenta or membranes. In such circumstances the operation gives excellent results, provided it be carried out in an aseptic manner.

Formerly most authorities recommended curettage in *puerperal infection*, in the belief that by its means the focus of infection could be removed. The operation is undoubtedly beneficial in a certain number of cases, but should be instituted only in the presence of definite indications, as its routine employment is frequently more dangerous than the original infection, and has led to the death of many hundreds of women. Generally speaking, it is contra-indicated when the infection is due to the streptococcus, as under such circumstances the lesions attending its use simply offer new areas for infection. On the other hand, it is often followed by excellent results when the so-called putrefactive organisms are producing the mischief, and particularly when the uterine cavity contains necrotic tissue or larger or smaller portions of degenerated placenta. Nevertheless, even in this class of cases it is generally better to employ the fingers in emptying the uterus.

**The Tampon or Pack.**—The vaginal tampon is occasionally indicated in the following conditions: inevitable abortion, certain cases of placenta

*prævia*, and to dilate the cervix in the early months of pregnancy. Profuse hæmorrhage occurring in the early months of pregnancy usually indicates that *abortion* is inevitable. In such cases, if the cervical canal is not sufficiently dilated to admit the finger, and instrumental dilatation does not seem indicated, it is sometimes advisable to pack it and the vagina tightly with sterile gauze. When the packing is removed twelve or twenty-four hours later, the product of conception is frequently found lying free in the vaginal vault, and when this does not occur the cervical canal will usually be sufficiently dilated to permit the introduction of the finger, by means of which the uterus can be emptied.

In *placenta prævia*, when the hæmorrhage is alarming and the cervical canal is not sufficiently dilated to admit a finger, certain authorities recommend the application of a tight tampon to the cervical canal and vagina. This effectually controls hæmorrhage, and on its removal a few hours later the cervix will usually be sufficiently dilated to admit two fingers, after which combined version by the Braxton Hicks method can be performed, or a Champetier de Ribes's balloon introduced.

In the early months of pregnancy a tightly applied pack offers an uncertain means of *dilating the cervix* in any condition which demands the evacuation of the uterine contents, when rapid instrumental dilatation appears undesirable. This is particularly true in hydatidiform mole and in certain cases of so-called missed abortion.

The best material for a vaginal tampon is gauze, which is most conveniently handled in the shape of roller-gauze bandages, 3 or 4 inches wide, which have previously been carefully sterilized. For the introduction of the pack, the patient should be brought to the edge of the bed and pre-

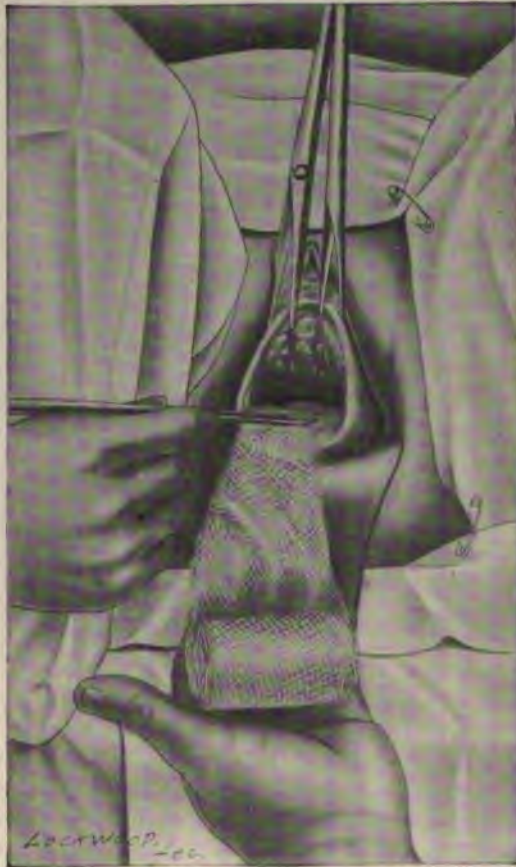


FIG. 441.—PACKING THE UTERUS FOR POST-PARTUM HÆMORRHAGE.



pared as for an operation. A bivalve, or preferably a Simon, speculum is then introduced into the vagina and the cervix seized with a bullet forceps. Then with a long dressing forceps the bandage is carried up and tightly packed into the cervical canal, and afterward into the fornix, so that eventually the entire vagina is completely filled with it.

*Intra-uterine Pack.*—Dührssen, in 1887, advocated packing the uterus with iodoform gauze as a means of controlling hæmorrhage. Whenever there is persistent loss of blood following the third stage of labor, which does not yield to the ordinary methods of treatment, this procedure offers a most efficient method of controlling it, as the pack not only exerts pressure upon the bleeding vessels, but mechanically stimulates the uterus to renewed contraction. Plain sterilized gauze may be substituted for that impregnated with iodoform or other antiseptics.

Before resorting to this procedure, however, it is essential that the hand be introduced into the uterus in order to ascertain that the hæmorrhage is not due to retention of portions of the placenta. If the uterus is empty, after the usual preparations for an operation have been carried out, one blade of a Simon speculum is introduced and the posterior vaginal wall retracted; the anterior lip of the cervix is then seized with a bullet forceps and drawn down as near as possible to the vulva, after which sterilized bandages are rapidly packed into the uterine cavity by means of a long dressing forceps, the upper part of the vagina being also tamponed (Fig. 441). The pack should be allowed to remain in place for twenty-four hours, after which it can be removed by traction upon its free end.

**Manual Removal of the Placenta.**—When considering the treatment of the third stage of labor, it was pointed out that previous to the introduction of Credé's method of expressing the placenta its manual removal was frequently resorted to. With increasing knowledge as to the proper conduct at this time, however, the operation became less and less frequently demanded, so that at present competent obstetricians consider that it is indicated only about once in several hundred cases, and then only when abnormal adhesions exist between the placenta and the uterine wall, or when one has to do with a placenta membranacea or succenturiata.

Manual removal is indicated whenever there is alarming hæmorrhage and the placenta cannot be expressed by Credé's method, though such a condition is but rarely observed. On the other hand, if there is no hæmorrhage, the operation should not be resorted to merely to hasten the completion of the third stage of labor. Generally speaking, in such cases, repeated attempts at expression by Credé's manœuvre should be persisted in for at least an hour, under anæsthesia, if necessary, and manual removal resorted to only after prolonged effort has shown that more conservative methods are ineffectual. The procedure is attended by grave danger, and offers a greater opportunity for infection than any other obstetrical manipulation. In the ordinary operations, such as forceps and version, the hand, when introduced into the uterus, is within the amniotic cavity, and consequently micro-organisms which may have been introduced along with it are cast off when the after-birth is expelled; whereas, in manual removal of the placenta the hand is inserted between the foetal membranes and the

uterine wall, and, in separating the placenta from its attachments, comes in direct contact with the thrombosed sinuses. The latter may be regarded as blood serum culture tubes awaiting inoculation, so that if pyogenic bacteria are introduced, abundant facilities for their further growth are offered.

When the operation becomes necessary, the strictest attention should be given to every aseptic detail. The external genitalia should be most



FIG. 442.—MANUAL REMOVAL OF PLACENTA.

rigorously cleansed, the hands and forearms of the operator carefully re-disinfected, and encased in fresh rubber gloves. After grasping the uterus through the abdominal wall with one hand, the other, lubricated with sterile vaseline, is introduced into the vagina and passed into the uterus, following the umbilical cord. As soon as the placenta is reached, its margin should be sought for, and the inner surface of the hand insinuated between it and the uterine wall. Then, with the back of the hand in contact with the latter, the placenta should be peeled off from its attachment by a motion similar to that employed in cutting the leaves of a book. After its complete separation, the placenta should be grasped in the entire hand, but not extracted immediately, the operator waiting until the uterus contracts down firmly over the hand, which should then gradually be withdrawn.

Once again, the importance of a most rigid aseptic technique in carrying



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out this procedure must be emphasized. Naturally, when the obstetrician finds himself face to face with an alarming post-partum hæmorrhage, his only thought is likely to be as to the most rapid method of checking it, without regard to details. But even in such cases, the hand should be carefully re-disinfected, or at least encased in a freshly boiled rubber glove, for, if it be introduced into the uterus without proper precautions, the patient, although saved from death from hæmorrhage, may succumb to a virulent infection a few days later.

## SECTION VI

### *PATHOLOGY OF PREGNANCY*

#### CHAPTER XXV

##### ACCIDENTAL COMPLICATIONS OF PREGNANCY DUE TO DISEASE

Pregnancy may be associated with certain diseases which result from the condition itself, or by others which are to be regarded as accidental complications. The latter may have existed before the inception of pregnancy, or may have been acquired during its course.

As a rule, all diseases which subject the organism to a considerable strain are much more serious when occurring in the pregnant woman. Thus, a lung which is partially destroyed or thrown out of function may suffice for the respiration of an ordinary individual, but be unable to respond to the added demands of pregnancy, particularly in the later months, when the enlarged uterus restricts the mobility of the diaphragm. Similarly, many a woman is unaware of the existence of a cardiac lesion, or at least leads a very comfortable existence, until the increased demands upon the activity of the heart incident to pregnancy bring about broken compensation with its attendant symptoms.

In general, it may be said that pregnancy exerts a deleterious influence upon all chronic organic maladies, while its effect is usually less marked in acute infectious processes. The latter, however, frequently lead to premature delivery, and the additional physical strain attending the latter may render the course of the disease much less favorable.

**Pregnancy Complicated by Acute Infectious Diseases.**—*Small-pox.*—Small-pox complicating pregnancy carries with it a more serious prognosis than at other times. Thus Vinay reported a mortality of 36 per cent. in 235 cases, as compared with 25 per cent. in the non-pregnant condition. The hæmorrhagic form of the disease is particularly fatal in pregnant women, Mayer having recorded the loss of 13 consecutive cases.

Moreover, small-pox exerts a deleterious influence upon the product of conception, although the incidence of abortion or premature labor varies with the severity of the disease, Queirel stating that it is almost universal in the hæmorrhagic, and comparatively infrequent in the discrete, variety. This may be due to hæmorrhagic changes in the decidua, or to the direct transmission of the disease to the fœtus, with its subsequent death and expulsion. The occurrence of intra-uterine small-pox is well authenticated, as children are occasionally born in the eruptive stage of the



disease or with distinct pock-marks. Mauriceau is said to have been infected in this manner, and the condition was well known to John Hunter and Smellie. It is stated that this is occasionally observed even when the mother presents no sign of the disease. Moreover, in double-ovum twin pregnancy it sometimes happens that one child is definitely pock-marked, while the other shows no signs of the disease.

Bollinger first suggested the possibility of the transmission from mother to foetus of the protective influence of vaccinia, and stated that when the mothers are successfully vaccinated during pregnancy a certain number of the children fail to take when vaccinated soon after birth. Behm noted this insusceptibility once in 29 cases, and believed that it was due to the transmission of an immunizing substance through the placenta. Kolloch held similar views. On the other hand, most authorities are sceptical as to the possibility of such an occurrence, and consider that unsuccessful vaccination in young children indicates that they are refractory to its influence, or that the virus was of poor quality. In 46 cases reported by Wolff, Palm, and Gast there was not a single instance of successful intra-uterine transmission.

*Scarlet Fever.*—It is generally believed that the pregnant woman possesses a certain immunity to scarlet fever. Braxton Hicks and others considered that this was demonstrated by the fact that the disease occurs much less frequently during pregnancy than in the puerperium. Ols-hausen, who also held this view, was able to collect from the literature only 7 cases of scarlet fever occurring in the former, as compared with 134 in the latter, period. It is quite possible, however, that many of the puerperal cases were not examples of true scarlet fever, confusion having arisen on account of the rash which sometimes occurs in puerperal infection. The correctness of this latter supposition is supported by the fact that many authors believe in the intercommunicability of the two diseases, a point that cannot be demonstrated until the *materies morbi* of scarlet fever has been discovered.

When occurring in the early months of pregnancy, the disease frequently causes abortion. This accident is usually attributed to the high temperature of the mother, though in very rare instances it may be due to the direct transmission of the disease to the foetus, Ballantyne having recorded a case in which the child presented a characteristic rash at birth. This view, however, has never met with any general acceptance.

*Measles.*—Measles is not a frequent complication of pregnancy, but when it occurs is very prone to cause premature delivery, which was observed by Klotz in 9 out of 11 cases. According to Fellner, the prognosis is much more serious during the puerperium than during pregnancy. It is stated that intra-uterine transmission of the disease to the foetus is now and again noted, Lomer, Fiori, and others having reported cases in which the child presented a characteristic eruption at birth.

*Cholera.*—Pregnant women do not appear to be attacked by cholera more frequently than others, although they succumb more readily to the disease. Schütz states that the mortality among them in the Hamburg epidemic of 1892 was 57 per cent.

The disease exerts a very deleterious effect upon pregnancy, 54 per cent. of the cases, according to Schütz, ending in abortion or premature labor. This may be due to various causes. One-third of the women suffering from cholera have more or less profuse uterine hæmorrhage, which, when occurring during pregnancy, gives rise to serious changes in the decidua, Slavjansky having described a peculiar form of hæmorrhagic endometritis. Moreover, in nearly every instance, the disease causes uterine contractions, supposed to result from the circulation of toxins in the blood.

Most authorities do not believe in the direct transmission of cholera bacilli to the child, Tizzoni and Cantani being the only investigators who have demonstrated it for human beings; but Vitanza's experiments render it probable that such an occurrence is quite frequent in animals.

*Typhoid Fever.*—Typhoid fever is a serious, and often a dangerous, complication of pregnancy. Moreover, it increases largely the foetal mortality, abortion or premature labor occurring in from 40 to 60 per cent. of the cases. Formerly it was held that the death of the foetus and its subsequent expulsion were due to the high temperature characterizing the disease; but it is now believed that it is usually due to the direct transmission through the placenta of toxins or of the bacilli themselves. Since F. W. Lynch, in my clinic, demonstrated the bacilli in the organs of a foetus aborted by a woman suffering from typhoid fever, we have repeatedly made similar observations, so that it is permissible to conclude that the foetus succumbs to a typhoid septicæmia. The literature upon the subject was collected by Knapp in 1909.

*Pneumonia.*—The maternal mortality is materially augmented when pneumonia occurs during pregnancy, since the disease frequently leads to premature labor or abortion. This result is usually due to imperfect oxygenation of the foetal blood, though in a small number of cases it is attributable to the direct transmission of bacteria to the foetus, in whose organs pneumococci have been demonstrated by Levy, Netter, Carbonelli, Lubarsch, and others.

Premature labor is a very untoward complication in such cases, as the exertion incident to it subjects the already weakened maternal organism to so great an additional strain that death frequently results.

*Influenza.*—According to many authorities, influenza exerts a very pernicious influence upon pregnancy, Felkin and Müller having observed premature labor in 6 out of 7, and in 15 out of 21 cases, respectively. In most of these cases the interruption of pregnancy was preceded by profuse metrorrhagia, which was supposed to be directly connected with the disease. On the other hand, Bar and Boullé, and Ahlfeld state that the disease is almost without influence upon gestation, the first-named observers having noted premature delivery only twice in 41 cases. It would appear, therefore, that the effects of influenza must vary with the severity of the epidemic, and more particularly with the frequency of pneumonic complications.

*Erysipelas and Sepsis.*—Erysipelas is a very serious disease at any time, but is particularly dangerous when occurring in pregnant women, in whom the possibility of a streptococcic puerperal infection is markedly increased.



That this does not always occur is shown by the fact that I have delivered several pregnant women suffering from severe facial erysipelas without infection. Occasionally, as noted by Lebedeff, the streptococci which have given rise to the erysipelas may be transmitted from mother to child, though this is unusual. A general septicæmia sometimes follows a streptococcic angina, and in such cases streptococci can be found in the uterine lochia, as well as in the foetal blood.

Furthermore, as a rule, any septic condition offers a worse prognosis in pregnancy than at other times. Krönig has reported several instances of transmission of the offending bacteria to the child, having demonstrated the transmission of colon bacilli from a parametritic abscess. He made similar observations in an infectious process due to an anaerobic bacillus, as well as in several cases of streptococcic infection.

*Gonorrhœa.*—The occurrence of gonorrhœa in the pregnant woman should never be lightly regarded. In not a few instances the organisms invade the decidua and give rise to inflammatory conditions which lead to abortion. Gonococci have been demonstrated in decidual endometritis by Neumann, Maslovsky, myself, and others.

More important, however, are the consequences of gonorrhœal infection at the time of labor and during the puerperium, leaving out of consideration, for the present, the frequency of ophthalmia neonatorum, to which reference has already been made. After labor the gonococci, which have remained limited to the cervical canal during pregnancy, may gain access to the uterine cavity and give rise to febrile phenomena. The condition, although rarely fatal, is always serious, since it frequently leads to involvement of the uterine appendages, which may render the patient permanently sterile, or even necessitate operative measures at a later date. In rare instances the gonococcus may produce a general infection, Dabney and Harris, and J. T. Smith having reported cases of gonorrhœal endocarditis observed in women delivered at the Johns Hopkins Hospital.

*Tetanus.*—Always a very dangerous disease, tetanus is fortunately a rare complication of pregnancy, nor does it appear to be more fatal than in non-pregnant women. Archambaud has reported a case which terminated favorably.

*Anthrax.*—Anthrax, or malignant pustule, is rarely observed in human beings under any circumstances, but is almost always fatal. Rostowzen met with three deaths in pregnant women, and was able in each case to demonstrate anthrax bacilli in the tissues of the child. A similar observation was made by Paltauf. Ahlfeld and Marchand have reported a case in which a child, born of a mother suffering from anthrax, died a few days after birth from the same disease. It remained doubtful, however, whether the case was one of intra-uterine transmission or of post-natal infection. In certain animals, on the other hand, the placental transmission of anthrax can frequently be demonstrated experimentally. The first observations of this character were made by Strauss and Chamberlent in 1882.

**Pregnancy Complicated by Chronic Infectious Diseases.**—*Tuberculosis.*—Formerly it was believed that pregnancy exerted a beneficial effect upon

tuberculosis, the mother improving markedly as long as she carried the child, though she frequently succumbed rapidly after its birth. At present, however, it is generally conceded that its effect is almost always harmful. Moreover, the strain incidental to labor and the extra drain upon the system, if the mother nurses the child, pull such patients down still further, so that the final result is usually hastened.

On the other hand, the disease does not appear to predispose to premature interruption of pregnancy, and it is not unusual for tuberculous patients to give birth to large and splendidly developed children at full term.

Occasionally tuberculosis may be transmitted from mother to child. Hauser (1898) collected from the literature 18 cases in which the transmission of tubercle bacilli was definitely demonstrated; while Sitzenfrey in 1909 showed that it occurred quite frequently, being able to demonstrate the bacilli in the blood of two out of a series of 26 children born of tuberculous mothers. In congenital tuberculosis the infection usually occurs through the placenta by means of the blood current, as is proven by the fact that the most advanced lesions are usually situated in the liver.

Following the description by Lehmann of the first cases of placental tuberculosis, the subject has been carefully studied by many investigators. Schmorl and Geipel, and Novak and Ranzel, collected 19 and 39 such cases in 1904 and 1910, respectively. As the former investigators were able to demonstrate lesions in the placenta in 9 out of 20 pregnant women dying from tuberculosis, and the latter found tubercle bacilli in 7 out of 10 placenta from women in various stages of the disease, it is apparent that the condition occurs more frequently than is generally believed, and confirms the opinion of Baumgarten and Maffucci that the incidence of congenital tuberculosis is generally underestimated.

The possibility of germinal infection should also be borne in mind. Friedmann in experiments upon rabbits and guinea-pigs showed that tubercle bacilli may be carried to the ovum by means of the spermatozoa; while Sitzenfrey has demonstrated in women dying from tuberculosis the presence of bacilli in the interior of ova while still within the Graafian follicle. It is, of course, questionable whether such infected ova could go on to development, but if it should occur and the bacilli should lie dormant for some time, such observations would afford a plausible explanation for some of the instances in which the tuberculosis does not become manifest until some time after birth.

When one considers, however, the large number of tuberculous women who become pregnant, and the very small proportion of cases in which the transmission of the disease to the foetus has been demonstrated, it is apparent that the latter must be an exceptional occurrence. Presumptive evidence in favor of this view was supplied by one of my patients, who died from tuberculous peritonitis a short time after delivery. At autopsy the exterior of the uterus was found studded with tubercles, while the interior was covered with tuberculous ulcers and caseous material, yet the child presented no signs of the disease, and was perfectly well some months later.



It would appear, therefore, that in the vast majority of cases the disease is not transmitted directly from the mother to the foetus, and that the latter is born with a tendency to tuberculosis rather than with the disease itself. Hence it follows that the children of tuberculous mothers should be brought up under the best hygienic surroundings, and should not be suckled by their mothers.

In view of the fact that the tuberculous process usually becomes exacerbated either during pregnancy or after childbirth, most authorities recommend that abortion be induced as a matter of routine in all tuberculous women, and many that they be rendered sterile by operative means. This appears to be a somewhat too extreme point of view, but I consider that abortion should be induced in the first pregnancy occurring after the onset of the disease, or whenever it makes its appearance during the early months of pregnancy, in order to give the patient every opportunity to place herself under such dietetic and climatic conditions as may offer every chance of curing or arresting the disease, rather than to run any risk of its exacerbation after labor. The patient and her husband should then be warned of the danger of future pregnancies until the process has become either arrested or cured, and the propriety should be considered of effecting temporary sterility by operative means. If the latter be not done, and conception should occur in spite of the warning, I hold that repeated abortion is indicated only in exceptional instances; as otherwise the obstetrician may find himself called upon to repeat the operation at frequent intervals. On the other hand, when the pregnancy is far advanced, I do not consider the induction of premature labor justifiable, as experience teaches that its effect upon the patient is quite as deleterious as labor at term, while the chances for the child are greatly diminished. Exceptionally, if the mother is so ill that it seems improbable that she will live until the end of pregnancy, the operation may be performed solely in the interest of the child.

*Malaria.*—Despite the somewhat widespread opinion to the contrary, it would appear that the ordinary forms of malaria have but little influence upon the course of pregnancy, although Goth has reported that 19 out of 46 cases ended in premature labor, and Edmonds states that this accident is very common in Africa.

I have observed 15 cases of malaria complicating pregnancy, the diagnosis being assured by the demonstration of the characteristic plasmodium. None of these patients aborted, and in but two did pregnancy end prematurely, and then only a week or so before term. It is probable, however, that the pernicious forms of malaria may have a much more deleterious effect. There is a marked tendency toward recrudescence of the disease during pregnancy and the puerperium, just as is frequently observed after surgical operations.

It is generally stated that the disease is frequently transmitted to the foetus, Runge believing that conclusive evidence of such an occurrence is afforded by the presence of characteristic pigmentation in its organs, while Kolloch says that it is not unusual for the new-born child to have characteristic malarial attacks. In a number of our cases the patients were suf-

fering from malaria at the time of labor, but in no instance did the foetus present signs of the disease, though in all such cases its blood was carefully and repeatedly examined for malarial parasites.

Quinine should be administered unhesitatingly to women suffering from malaria during pregnancy, as its oxytoxic properties are apparently in abeyance under such conditions, so that it can be used with impunity without fear of setting up uterine contractions.

*Syphilis.*—Syphilis is one of the most important complications of pregnancy, as it is one of the most frequent causes of repeated abortion or premature labor. It should be suspected in all cases in which a perfectly satisfactory explanation for this accident cannot be adduced.

When infection occurs during pregnancy, owing to the vascularity of the parts, the initial sore may assume larger proportions than under ordinary circumstances. The secondary lesions, however, are often but slightly marked, and frequently are practically limited to the genitalia, where they appear as large, elevated areas which occasionally undergo ulcerative changes, and sometimes lead to the destruction of superficial portions of the vulva.

The influence of syphilis upon pregnancy differs materially, and three classes of cases are distinguished, according as infection has taken place: (1) before pregnancy; (2) at the time of conception, or (3) during pregnancy.

When inoculation with the specific poison has occurred before conception, the disease nearly always gives rise to abortion or premature labor, more frequently the latter. Le Pileur obtained a striking illustration of the disastrous effects of syphilis from a study of the reproductive histories of 130 women before and after its inception, 3.8 per cent. of the children being born dead before, as compared with 78 per cent. after, infection.

In premature labor due to syphilis the child is usually dead when it comes into the world; less frequently it is born alive with definite manifestations of the disease. Again, in a still smaller number of cases, it may be born at full term without signs of the disease, which, however, make their appearance later; while occasionally, particularly when the infection had occurred some years previously, the child may never manifest any signs of the disease.

When the mother is suffering from the affection at the time of conception, the offspring is always syphilitic. The same applies when the infection and conception occur at the same time, but under such circumstances, however, it is a question whether the child owes the disease to paternal or maternal influences. On the other hand, when syphilis is contracted during pregnancy, its effect upon the foetus varies. If infection occurs within the first few months, the foetus, as a rule, likewise manifests signs of the disease, but when it occurs later the child may not become infected.

Until recently it was generally believed that foetal syphilis was frequently the result of paternal infection, and that a man suffering from the tertiary form might engender a syphilitic child without infecting his wife. This belief was based upon the observation that an apparently



healthy woman might give birth to a definitely syphilitic child, and be able to suckle it with impunity, whereas it would certainly infect another woman. Such an occurrence was well stated in the dictum known as Colles's law, which assumed a previous transmission of immunity from the foetus to the mother.

With the discovery of the spirochæta pallida by Schaudinn, and the utilization of the Wassermann reaction as a means of diagnosis, grave doubt has been cast upon the validity of this law, which is now denied by the great majority of investigators. In order for paternal transmission to occur it is necessary to suppose that the syphilitic virus is transmitted to the ovum by means of the spermatozoon. As long as the virus was merely hypothetical this did not seem improbable; but when Bab pointed out that the spirochæta is three times as long as the head of a spermatozoon, it appeared unlikely that the former could enter the ovum along with the latter, unless some spore-like intermediate form exists with which we are as yet unacquainted. Furthermore, the fact that the apparently healthy mothers almost universally present a positive Wassermann reaction has led most investigators to conclude that the immunity is only apparent, and is due to the fact that such women are really suffering from a latent syphilis, which does not give rise to symptoms.

Notwithstanding these potent arguments, I am not yet prepared to deny the validity of Colles's law, for the reason that it seems to offer a plausible explanation for certain definite clinical manifestations, and also because I cannot rid myself of the idea that the constant casting off into the maternal circulation of fragments of the ovum—in the shape of fragments of chorionic villi—would seem to offer an almost ideal means of bringing about immunity.

Further consideration of this question, as well as of the syphilitic lesions of the child and the placenta, will be taken up in the chapter upon Diseases of the Ovum.

Whenever we obtain a history of syphilis in either parent, no matter whether infection has occurred prior to or at the time of conception, the mother should at once be treated by salvarsan, followed by a course of specific treatment, as by its means not only may she be cured, but, in view of the fact that the arsenical and mercurial salts, as well as iodide of potassium, are readily transmitted through the placenta, the foetus may be also treated, no matter whether its infection be of maternal or germinal origin.

In view of the practical application of Colles's law, the syphilitic child may be suckled with impunity by its own mother. If, however, she is unable to nourish it, it should never be given to a wet-nurse, but should be fed artificially.

**Diseases of the Circulatory and Respiratory Systems.—Valvular Lesions of the Heart.**—While the work of Stengel and Stanton, and most recent authors, tends to show that little if any hypertrophy of the heart occurs during pregnancy, the investigations of James Mackenzie indicate that there normally occurs a certain amount of derangement in the cardiac function. He bases his conclusions upon the fact that the following con-

ditions may frequently be noted: (1) limitation of the field of cardiac response; (2) changes in the rate and rhythm of the heart; (3) dilatation of the right side of the heart; (4) tendency to œdema of the lungs; (5) tendency to overfilling of the veins of the legs, and (6) the occurrence of marked pulsation in the veins of the neck. As all of these conditions are more or less abnormal, and are likely to become greatly accentuated in pregnant women suffering from valvular lesions of the heart, there is good reason for considering such complications as serious. Guerard records a mortality of 28 per cent. in cases of valvular disease complicating pregnancy, and considers the condition more alarming than even eclampsia or placenta prævia. He states further that Schlayer, Leyden, Macdonald, and Lublinsky lost respectively 48, 54, 60, and 100 per cent. of such patients. These figures, however, give an exaggerated idea of the seriousness of the condition, as they apply only to those cases in which compensation has long since failed and the condition is complicated by renal changes or the toxæmia of pregnancy. Jaschke, on the other hand, states that the danger is greatly overestimated, as in a series of 1,525 cases observed in Vienna the mortality was only 0.39 per cent.

Routine examination shows that heart lesions are present in a considerable proportion of cases, being observed by Demelin in 1.23, by Vinay in 2, and by Fellner in 2.4 per cent. of all pregnant patients. In a series of 94 cases Fellner observed the following lesions:

|                                 |    |
|---------------------------------|----|
| Mitral insufficiency .....      | 37 |
| Mitral stenosis .....           | 5  |
| Combined mitral lesions .....   | 34 |
| Aortic insufficiency .....      | 3  |
| Aortic and mitral lesions ..... | 10 |
| Uncertain lesions .....         | 5  |
| Myocarditis .....               | 2  |

He also stated that only one-seventh of such cases showed cardiac manifestations, whereas Demelin noted them in two-thirds of his series.

From my own experience, I should say that apparently functional cardiac murmurs are frequently heard in pregnancy, while serious organic lesions occur once in several hundred cases, and are accompanied by dyspnœa and œdema during the latter part of pregnancy, and occasionally some degree of collapse is noted shortly after labor. On the other hand, one occasionally sees cases with broken compensation associated with such urgent symptoms that the induction of abortion or premature labor is clearly indicated. In several of my cases the symptoms were most alarming. One multiparous patient, suffering from uncompensated mitral disease, collapsed in the last month of pregnancy, with signs of acute dilatation of the heart and intense pulmonary œdema. Death was averted by blood-letting and the induction of premature labor; while in two other patients the condition was so alarming that Cæsarean section was performed.

It is generally believed that the most untoward symptoms are observed in mitral stenosis. Lusk regarded this lesion as sufficiently serious to war-



rant the induction of abortion as soon as the diagnosis is made. On the other hand, French and Hicks, after studying the obstetrical records of 300 women treated in Guy's Hospital for this condition, state that it is no more serious than other lesions. The fact that 135 of their patients went through 608 labors without a break in compensation clearly indicates that the condition is less serious than is generally believed.

Generally speaking, the prognosis is good so long as compensation is retained. To this, however, there are certain exceptions, as Zweifel has recorded two cases in which collapse and death occurred in pregnant women who had previously been absolutely unaware of their condition. On the other hand, if compensation fails, and appropriate therapy does not bring about an amelioration of the symptoms, the prognosis becomes ominous; for even if the patient be saved from immediate death by the induction of premature labor, serious complications are usually in store for her in the future.

Grave heart lesions complicating pregnancy are generally believed to predispose to premature labor, which was noted in 20.2 per cent. of Fellner's cases, as compared with 5.5 per cent. in those of French and Hicks. This accident may result from uterine hæmorrhage directly attributable to the cardiac condition, from the death of the foetus due to insufficient oxidation, or from changes in the placenta. In not a few cases there is more or less profuse hæmorrhage immediately following delivery; or, again, at the time of labor, owing to the elevation of arterial pressure incident to the uterine contractions, compensation may fail and the woman's life may be in peril. Moreover, collapse may manifest itself immediately after the expulsion of the child, as a result of the marked fall in the arterial pressure which occurs at that time.

If the lesion is fairly compensated the patient should be kept under close observation, rest being ordered and digitalis or some other heart tonic being employed as soon as symptoms appear. If this treatment fails to bring about the desired result, pregnancy should be promptly ended by the most conservative method available.

The psychical disturbances incident to labor, and the elevation of arterial pressure brought about by the abdominal and uterine contractions, render it advisable to make use of an anæsthetic during the second stage. As soon as the cervix is completely dilated and the head well engaged in the pelvis, the termination of labor by forceps is indicated.

Some authorities recommend that women suffering from heart lesions should be dissuaded from marriage, or, if married, from becoming pregnant. This, however, appears to be an extreme view, though, of course, when the lesion is serious and the compensation faulty, the dangers of childbearing should be carefully explained.

*Myocarditis.*—Owing to the difficulty in making an exact diagnosis, myocarditis is rarely recognized during life. Nevertheless, it is a most serious complication of pregnancy, and is one of the frequent causes of sudden death during the second stage of labor and the first few hours of the puerperium.

Occasionally cases of tachycardia are observed during pregnancy for

which no explanation can be given. Thus, in a multiparous patient the pulse-rate varied between 120 and 140 during the last three months of each pregnancy, but returned to normal within a few days after delivery. As a thorough physical and urinary examination failed to reveal any abnormality, I was forced to make the unsatisfactory and provisional diagnosis of neurotic tachycardia.

*Endocarditis.*—Acute endocarditis may appear during pregnancy, just as at other times. It should always be regarded as a serious matter, but particularly so at this time, as occasionally the bacteria giving rise to it may be transmitted to the fœtus and cause its death, while in other cases small portions of the vegetations upon the valves may be broken off and give rise to apoplexy or embolism.

*Phlegmasia.*—Thrombosis of the veins of the thigh, or phlegmasia, is a very rare complication of pregnancy. F. C. Goldsborough in 1904 reported a case observed in my service and collected the literature upon the subject. It should be regarded as a very serious condition, particularly in view of the fact that incautious manipulations may lead to the detachment of small particles of a thrombus, which may then give rise to embolism of the pulmonary arteries. The symptoms and treatment are dealt with in Chapters XLIII and XLIV. On the other hand, thrombosis of the superficial vessels of the leg is frequently observed in women suffering from varicose veins, and can usually be regarded with great equanimity.

*Pulmonary Embolism.*—Embolism of the pulmonary arteries is a very rare complication of pregnancy. Barnes reports one case which ended fatally within a few moments, while Sperling has reported a second which eventuated in recovery. The condition should always be borne in mind in cases of sudden death during pregnancy which cannot otherwise be explained.

*Emphysema.*—When pregnancy occurs in women suffering from advanced emphysema, the dyspnoea may become so intense as to demand its artificial interruption. In a certain number of cases abortion or premature labor occurs spontaneously, the untimely uterine contractions being attributed to insufficient aeration of the blood.

*Asthma.*—The symptoms of asthma are sometimes markedly aggravated during pregnancy. In some patients the disease makes its appearance only during pregnancy or at the time of labor, disappearing spontaneously after childbirth. If the usual methods of treatment fail, cure may sometimes be effected by placing the patient upon an absolute milk diet, although careful analysis of the urine may not indicate the existence of a toxæmia. If this is ineffectual, a radical change of air sometimes proves beneficial.

*Dyspnoea.*—Almost every woman in the last few weeks of pregnancy suffers more or less from shortness of breath resulting from interference with the motility of the diaphragm by the enlarged uterus. Dyspnoea occurring in the earlier months of pregnancy is usually due to cardiac or renal disease, and demands a thorough physical examination. Occasionally it follows excessive distention of the uterus, as in hydramnios.

*Varices.*—Owing to the pressure of the pregnant uterus upon the veins



returning from the thighs, and the fact that they are but poorly supplied with valves, abnormalities in their circulation are frequently observed during pregnancy, and manifest themselves by the appearance of varicose veins. These may assume considerable proportions in the legs or about the vulva, and give rise to distressing symptoms. In rare cases, particularly when they are situated at the vulva, their rupture may lead to fatal hæmorrhage. When they occur in the legs, marked relief is often obtained by the use of neatly applied bandages or elastic stockings. Active treatment is useless in vulval varices, but the danger of their rupture should be borne in mind at the time of labor.

*Edema.*—Edema is a very frequent complication of pregnancy. It may be general and involve any portion of the body, but is usually lim-



FIG. 443.—EDEMA OF VULVA.

ited to the lower extremities. Occasionally the vulva becomes intensely œdematous. When limited to the extremities, the swelling usually results from pressure exerted by the enlarged uterus upon the veins returning from the legs. On the other hand, if it be generalized, it is likely to be a manifestation of toxæmia, or even of an acute nephritis, though occasionally it may be due to other causes. Similarly, œdema of the vulva may be purely mechanical or a manifestation of some systemic disturbance.

The patient should be cautioned as to the significance of œdema, and whenever it appears the urine should be carefully examined. If the kidneys are found to be doing their work properly, the swelling is probably of mechanical origin and usually is not amenable to treatment, though

the condition may be markedly benefited by restricting the movements of the patient, or even confining her to her bed. If the urine be abnormal, the condition is more serious, as it is a manifestation of toxæmia of pregnancy, and should be treated accordingly.

When the marked swelling about the vulva is a source of discomfort and annoyance, and is not relieved by medicinal treatment, relief may be given by puncturing the most dependent portions of the swollen labia and allowing the serum to drain off. This slight operation should always be done under the strictest aseptic precautions, and the labia afterward covered with sterile dressings, inasmuch as infection can readily occur and may be followed by serious consequences.

**Diseases of the Alimentary Tract and the Liver.**—*Icterus.*—Pregnancy is comparatively seldom complicated by jaundice, which is usually due to catarrhal processes in the duodenum or to cholelithiasis. The catarrhal variety is generally without significance and undergoes spontaneous cure. At the same time, it should be borne in mind that jaundice may represent the onset of acute yellow atrophy of the liver; while its association with pernicious vomiting, toxæmia or eclampsia is indicative of profound lesions in the liver, and adds greatly to the seriousness of the prognosis; for this reason a careful urinary analysis should be made before diagnosing a simple catarrhal icterus.

Epidemics of jaundice have been recorded in various portions of the world, in which the disease ran its usual course in men and non-pregnant women, but was most disastrous in pregnancy, as some of the women died in coma and many more aborted or fell into labor prematurely. Moreover, it would seem that pregnancy sometimes predisposes to the occurrence of jaundice, as Van den Velden and others have recorded instances in which it occurred in successive pregnancies and was frequently associated with hæmoglobinuria.

It is generally believed that women suffering from jaundice at the time of labor have a tendency to hæmorrhage, but this was not noted in the few cases which I have seen.

*Gall-stones.*—The fact that cholelithiasis occurs more frequently in women than in men would suggest a possible association with the reproductive function. Acute attacks may occur during pregnancy or the puerperium, and Peterson in 1910 collected 25 operations performed in the former, and 10 in the latter period. It is always a serious complication, and operation, if urgently demanded, should be undertaken without regard to the existence of pregnancy. In less urgent cases it is, of course, advisable to postpone interference until after the child has become viable.

*Acute Atrophy of the Liver.*—This condition will be considered in the chapter on the Toxæmias of Pregnancy.

*Indigestion.*—Pregnant women frequently suffer from indigestion, and the symptoms arising from it are sometimes very distressing. Kehrer is inclined to attribute them, at least in part, to the decrease in the amount of gastric hydrochloric acid, which he considers usual in pregnancy. Such cases should be treated without reference to the existence of pregnancy.



In many instances marked relief follows the administration of a wine-glass of cream a half hour before each meal.

*Constipation.*—Owing to distention by the growing uterus, the abdominal walls may become so impaired in tonicity that considerable difficulty is experienced in evacuating the bowels. Indeed, it may be said that the majority of pregnant women suffer from constipation. This condition should be carefully guarded against in order to avoid auto-intoxication and increased strain upon the kidneys. It is best overcome by appropriate diet, regularity in going to stool, and the occasional use of pills of aloin, belladonna, and strychnine, the fluid extract of cascara, or compound licorice powder. The stronger cathartics should be avoided on account of their tendency to cause abortion.

*Enteroptosis.*—The neurasthenoid symptoms which so frequently accompany enteroptosis are often markedly ameliorated during pregnancy, inasmuch as the steadily enlarging uterus may tend to restore the displaced viscera to their normal positions. The comfort of the patient can be added to appreciably by the use of rational clothing, and especially by the application of a properly adjusted abdominal supporter. The condition, however, is prone to recur after childbirth unless the patient takes on considerable flesh. According to Maillart the improvement is sometimes permanent, especially if the relaxation of the abdominal walls be counteracted by the use of a snugly fitting binder during the puerperium and a suitable abdominal supporter afterward.

*Salivation.*—In exceptional instances the salivary secretion becomes markedly increased during pregnancy. As a rule, this is not a serious complication, but now and again the amount of saliva is so great as to cause the patient great annoyance, and sometimes even prevent her from sleeping. One of my own patients expectorated between 500 and 600 cubic centimeters of clear fluid every day for several weeks, while Lvoff has reported several cases in which the secretion in the twenty-four hours varied from 1,000 to 1,600 cubic centimeters.

The condition is usually attributed to a reflex neurosis incident to pregnancy, but sometimes it is a manifestation of auto-intoxication. In the first class of cases the treatment is very unsatisfactory, astringent mouth washes, and even comparatively large doses of atropine, being without effect. On the other hand, when the condition results from auto-intoxication, marked amelioration frequently follows placing the patient upon a rigorous milk diet.

*Gingivitis.*—Exceptionally, the gums of pregnant women become inflamed and spongy, and bleed upon the slightest touch. The condition is usually observed in run-down individuals, and is very refractory to treatment, although in many cases it disappears almost immediately after delivery. It is best met by the employment of astringent mouth washes, especially those containing tincture of myrrh, combined with general tonic treatment and an abundant diet.

*Dental Caries—Toothache.*—Many women suffer during pregnancy from dental caries, which may be associated with more or less severe toothache. It is a popular belief that pregnancy predisposes to the condition, as is

evidenced by the saying, "For every child a tooth." It is probable that the condition is somewhat allied to the minor degrees of osteomalacia which occur only during pregnancy. Such patients should be referred to a skillful dentist, and at the same time should be placed upon the syrup of the hypophosphites or the lactophosphate of lime.

**Diseases of the Kidneys and Urinary Tract.**—*Chronic Nephritis.*—Pregnancy occurring in patients suffering from chronic nephritis is always a serious complication, and will be considered in the chapter on the Toxæmias of Pregnancy.

*Glycosuria and Diabetes.*—Blot, in 1856, stated that sugar could usually be found in the urine of lactating women; but after it was demonstrated that the condition was a lactosuria, the belief gained ground that the existence of true diabetes was inconsistent with conception. This view was combated first in 1882 by Matthews Duncan, who was able to find in the literature 22 cases in which pregnancy was complicated by the disease, while in 1909 I collected 66 cases. Accordingly the condition is not frequent.

Diabetes may exist before the inception of pregnancy, or may appear during its course. The prognosis is generally believed to be ominous for mother and child. In the 66 cases which I collected, 27 per cent. of the mothers died at the time of labor or within two weeks afterward, while an additional 23 per cent. perished during the following two years. Moreover, about one-eighth of the pregnancies ended in abortion or premature labor, and in one-third of those going to term the children were born dead. Such statistics give too gloomy a picture, as they are based mostly upon the severe cases, and do not take into account the milder ones, which are usually overlooked.

Leipmann has stated that diabetic women are particularly prone to infection at the time of labor, and that gangrenous processes may occur in the uterus, in the form of metritis dëssicans, just as are sometimes noted in other portions of the body in non-pregnant individuals.

It is interesting to note that 7 of the 26 cases collected by Graefe were complicated by hydramnios, and that in five of these sugar could be demonstrated in the liquor amnii. According to Rossa, Ludwig, and Offergeld, such an occurrence may be regarded as affording presumptive evidence that the amniotic fluid is a maternal transudate, since no trace of sugar can be detected in the foetal urine.

On the other hand, too much emphasis cannot be laid upon the fact that the mere demonstration of sugar in the urine does not justify the diagnosis of diabetes with its serious prognosis. With the ordinary Fehling test, I obtained a distinct reaction for sugar in about 5 per cent. of all women in the last months of pregnancy. Ordinarily this is due to lactosuria and is of no clinical significance, but occasionally a true glycosuria is present. This occurs about once in 100 or 150 cases, and the amount of glucose may vary from  $\frac{1}{4}$  to 2 or 3 per cent. without materially complicating the prognosis, as the patients suffer no discomfort and are safely delivered at term, after which the sugar disappears. Moreover, I have seen the condition recur in succeeding pregnancies.



If more accurate chemical methods be used, sugar can be detected much more frequently, and Commandeur and Porcher state that traces occur at some time in the course of every pregnancy. They found glucose or lactose in 20 and 80 per cent. of their cases, respectively, and occasionally both varieties together.

Three theories have been advanced to explain the production of this variety of glycosuria. Payer has shown that pregnant women are less tolerant of sugar during pregnancy than at other times, as he was able to produce alimentary glycosuria in 80 per cent. of his patients by increasing the amount of sugar ingested. In one of my patients, the glycosuria disappeared upon substituting another aperient in place of a home-made syrup of senna and prunes, which she took in immense quantities for the relief of constipation.

Commandeur and Porcher hold that the condition is due to the inability of the non-functioning breasts to convert glucose into lactose, as normally occurs during lactation; while Hofbauer believes that it is dependent upon fatty changes at the periphery of the liver lobules, associated with a diminished ability to store glucose, which he considers a characteristic change accompanying normal pregnancy. I am inclined to regard most cases of slight glycosuria in pregnancy as physiological or alimentary in character.

This being the case, the first essential after obtaining a positive reaction with Fehling's solution is to determine by the fermentation test or by the polariscope whether one has to deal with lactose or glucose. If the former is present no anxiety need be felt, as lactosuria is frequently a perfectly physiological phenomenon. On the other hand, if glucose is present, the matter is not so simple, as it is most important to determine whether it is a manifestation of true diabetes or merely of an alimentary, physiological, or recurrent glycosuria. Unfortunately, this is not always easy. The former should be diagnosed if the condition existed prior to pregnancy, or if large amounts of glucose are demonstrable, but more particularly if the characteristic symptoms of thirst, emaciation, and dyspnoea are present; while a probable diagnosis of alimentary glycosuria is permissible if the glycosuria disappears upon removing sugar from the diet. Occasionally, however, slight glycosuria persists notwithstanding the most rigorous anti-diabetic *régime*; in such cases the patient should be carefully watched and the urine examined daily, and the pregnancy promptly terminated upon the first appearance of untoward symptoms. Fortunately, this will rarely be necessary, as the patient will usually go through pregnancy and labor without difficulty, and the glycosuria will disappear during the first days of the puerperium.

*Hæmaturia.*—The passage of bloody urine is rarely observed during pregnancy, and its occurrence should always lead one to suspect more or less serious lesions of the urinary tract. Nevertheless, Chiaventone has described an idiopathic hæmaturia due to pregnancy, and has collected 18 similar cases from the literature. He considers that the hæmorrhage is probably due to histological changes in the kidney which result from a hepato-toxæmia. He mentions, however, a case described by Albarran in

which the bloody urine was probably due to the presence of varicose veins in the wall of the bladder.

*Pyelitis and Pyelonephrosis.*—According to Vinay, attention was first called to this complication of pregnancy by Reblaud in 1892. Opitz in 1905 collected 84 cases, and since then an immense literature has accumulated upon the subject.

The disease usually appears in the latter half of pregnancy, when the patient, who had previously been perfectly well, or has merely complained of slight vesical irritation, is suddenly seized with intense paroxysmal pains, usually in the right renal region. This is accompanied by a marked elevation of temperature and occasionally by chills, the temperature pursuing a hectic course. Urinary examination reveals the presence of pus cells and bacteria. If the process goes on to the development of a pyelo-nephrosis, palpation shows that the affected kidney is markedly enlarged. After a certain time a large amount of purulent urine is suddenly passed, when the pain disappears and the kidney becomes smaller, the symptoms reappearing as the kidney fills again. If allowed to go on without treatment, the patient may succumb to a septic process.

The condition results from compression of the ureter at the brim of the pelvis by the pregnant uterus, with damming back of the urine, to which must be added an infectious process. The latter may be due to an extension upward from the bladder, or to transmission of bacteria through the blood or lymph channels, or from the intestines. *Bacillus coli* is the usual infecting agent, but the streptococcus, gonococcus, or tubercle bacillus is sometimes concerned. Ordinarily pain in one lumbar region and the palpation of the enlarged and tender kidney, as well as the detection of the enlarged and sensitive ureter on vaginal examination, should make the diagnosis clear. Yet the condition is frequently mistaken for appendicitis and occasionally for typhoid fever or salpingitis.

The treatment consists of rest in bed and an abundant but bland diet. The patient should be encouraged to drink large quantities of water and milk, and 5 grains of urotropin should be administered every four hours. Ordinarily improvement is rapid, but if it does not take place and the condition becomes alarming, premature labor should be induced without hesitation, as the emptying of the uterus removes the ureteral obstruction and allows of free drainage from the kidney into the bladder, the establishment of which, as a rule, is followed by complete recovery. Occasionally, in cases of pyelo-nephritis, the process may continue after emptying the uterus, and necessitate nephrotomy or even removal of the kidney. I see several patients each year with this complication, and the great majority recover spontaneously; occasionally the induction of premature labor is necessary, while in two neglected cases death occurred from a general septic process, due in one instance to the streptococcus and in the other to the gonococcus.

*Floating Kidney.*—The symptoms arising from a movable or floating kidney are usually considerably alleviated during pregnancy, as the enlarged uterus tends to retain the organ in its normal situation. In rare instances, however, the pedicle of the kidney may become twisted and give



## ABDOMINAL COMPLICATIONS DUE TO DISEASE

*Renal Colic.*—This may be mistaken for renal colic or appendicitis. A hot water bottle usually suffice for reduction, after which the symptoms usually subside.

*Increased laxity of the abdominal wall following child-birth.*—The symptoms are apt to become aggravated when the patient gets fat, as she has taken on considerable flesh, so that sufficient fat has accumulated about the kidney to hold it in place. A snugly applied bandage usually suffices to hold it through the puerperium.

*Incarceration of the Kidney.*—Cragin has reported an instance in which a kidney occupied the pelvic cavity, and has collected 5 more or less similar cases from the literature. The condition is rarely diagnosed before the onset of labor, though in Cragin's case symptoms of incarceration led to a physical examination and the diagnosis of the presence of a tumor, which was removed and found to be a kidney.

*Pregnancy After Removal of Kidney.*—Conception sometimes occurs in women from whom one kidney has been removed on account of tuberculous pyelonephritis, or some other lesion. Provided the remaining organ performs its functions properly, pregnancy may progress uneventfully, and in several of my cases the patient was delivered at term without incident; while Blevins in 1910 was able to collect 35 similar cases from the literature. At the same time it should be borne in mind that the single kidney may bear the strain of a toxæmia poorly; consequently the urine should be examined frequently, and the pregnancy interfered with at the first appearance of untoward symptoms.

*Cystitis.*—Pregnancy is occasionally complicated by cystitis, which is usually due to gonorrhœal infection, though the colon bacillus may be the infective agent. In view of the possibility of an ascending ureteritis and a resulting pyelonephritis, the condition demands prompt treatment.

*Floating Spleen.*—Occasionally an enlarged spleen occupying the lower abdomen may be mistaken for the pregnant uterus. If pregnancy supervenes, it is usually uninfluenced by the floating organ, which is gradually forced into its normal position as the uterus enlarges. Occasionally, however, pronounced peritonitic symptoms may appear as the result of torsion of its pedicle, when splenectomy will be indicated. The literature upon the subject up to 1907 has been well reviewed by Heil.

*Diseases of the Nervous System.—Paralysis.*—Paralysis of central origin sometimes occurs during pregnancy, and is frequently associated with toxæmic or septic processes. Thus, in the toxæmias of pregnancy and eclampsia, serious disturbances may follow œdema of the brain or apoplexy. In infectious processes thrombosis may occur in the cerebral vessels, and occasionally emboli may cut off the circulation of large areas of the brain and lead to various paralyses and even to death.

Paraplegia of spinal origin occasionally occurs, but, except in rare cases of toxæmia, is not directly dependent upon the existence of pregnancy. It does not appear that spinal paraplegias interfere with conception, as women suffering from them frequently become pregnant. In either event the condition is without influence upon the course of pregnancy, and in

many such cases, including advanced tabes dorsalis, labor is easy and comparatively painless.

*Neuralgia.*—Neuralgic pains are frequent concomitants of pregnancy. In rare instances they are very obstinate and resist all treatment, though they often disappear spontaneously after labor. During the later months of pregnancy the head of the child, after descending into the pelvis, may compress one or other sciatic nerve and give rise to severe pain along its course, which is sometimes accompanied by intense muscular spasm. Owing to its mode of origin, this form of sciatica is not amenable to treatment.

*Neuritis.*—Whitfield, Eulenberg, and others have directed attention to an idiopathic neuritis which occurs during pregnancy. Many cases are associated with severe vomiting of pregnancy, and, as the toxæmic origin of the latter has become recognized, the neuritis is considered as a manifestation of the same process, and not the result of pressure. It usually disappears spontaneously, but slowly, after childbirth. The affection may be limited to a single nerve, or may appear as a multiple neuritis. It is characterized by paralysis of the affected region associated with muscular atrophy and the presence of the characteristic reaction of degeneration. There is marked sensitiveness along the course of the affected nerves, which is frequently associated with shooting pains. Sensibility of the parts is markedly impaired, and the patients frequently suffer from parasthesiæ. Occasionally the symptoms are so severe that the induction of premature labor may be justifiable.

*Chorea.*—Pregnancy occasionally occurs in choreic individuals, while in rare instances the disease does not appear until after conception. In the first class of cases it is comparatively unimportant, while in the latter the choreic movements are sometimes so intense as to interfere with sleeping or the taking of food. In these cases of chorea gravis the patient becomes maniacal, and may abort spontaneously. The appearance of fever is of serious import, and at autopsy evidences of malignant endocarditis are present.

Schrock has collected 154 cases of chorea complicating pregnancy, with a mortality of 22 per cent., and Buist 255 cases, with a mortality of 17.5 per cent. French and Hicks in 1906 reported 29 cases which had been observed in Guy's Hospital in the previous thirty years, with a mortality of 10 per cent. Many of the cases did very well upon the usual medicinal treatment. They are skeptical as to the value of the induction of premature labor, but lay great stress upon the serious prognostic import of the appearance of fever. Jolly, on the other hand, recommends interference in all aggravated cases. The only case of the grave variety which I have seen died, in spite of the fact that she fell into premature labor spontaneously shortly after entering the hospital.

*Epilepsy.*—This disease appears to have no effect upon pregnancy, though at the time of labor it may be mistaken for eclampsia by inexperienced observers. If the attacks are frequent, the patient should be put upon large doses of potassium bromide and treated just as at other times. As a rule, it is not advisable to allow the mother to nurse her



child, as lactation sometimes appears to aggravate the disease, while serious injury might possibly be done to the child during an attack.

*Hysteria.*—Hysteria is a not infrequent complication of pregnancy, but does not appear to exert a deleterious influence upon its course. Indeed, the physical condition often undergoes marked improvement at such times. Occasionally, however, the hysterical symptoms may become aggravated. Many authors have of late been inclined to attribute the nausea and vomiting of pregnancy to hysteria. This is no doubt true in many cases, but certainly cannot be regarded as the sole cause of the condition.

*Tetany.*—In rare instances tetany may occur during the course of pregnancy, Meinert, in 1898, being able to collect 20 cases from the literature. In some patients the disease appears only during pregnancy and is absent at other times. H. M. Thomas observed a case at the Johns Hopkins Hospital, in which the condition had appeared in 6 successive pregnancies. A full *résumé* of the literature is to be found in his article.

Formerly tetany was thought to be connected in some way with abnormalities of the thyroid gland, as it sometimes occurred after the removal of that organ. Following the experimental work of Frommer, Adler and Thaler, and others, it is now believed to be due to the absence or imperfect secretion of the parathyroid bodies. The last-named investigators demonstrated that portions of the parathyroids could be removed from white rats without effect, but that symptoms of tetany would appear whenever the animals became pregnant.

*Goiter.*—We have already referred to the slight enlargement which the thyroid frequently undergoes during pregnancy. Bignami has reported a case which, in his opinion, proved that pregnancy occasionally exerts a pathological influence upon this gland. During his patient's first pregnancy the thyroid underwent considerable hypertrophy, but returned to its normal size after delivery. The condition returned in the second pregnancy, the enlargement reaching such proportions that death resulted from suffocation.

In rare instances pregnancy appears to cause a rapid increase in the size of a thyroid tumor, which had been present before its inception, and Ahlfeld, Albers-Schönberg, and Meinert have reported cases in which a goiter, which had previously grown only slowly or had remained stationary in size, became so large during pregnancy as to render tracheotomy or the operative removal of the growth necessary in order to prevent death from suffocation. In my experience pregnancy plays little or no part in the production of exophthalmic goiter, but there is no doubt that it exerts a deleterious influence upon the condition when it already exists. In several instances the tachycardia was greatly exaggerated, but became less marked after induced or spontaneous labor.

*Apoplexy.*—Apoplexy is rarely observed during pregnancy, though it is a not infrequent complication of eclampsia. When it occurs independently of the latter disease, it is usually the result of emboli due to endocarditis, or to phlebitis of the lower extremities.

*Disturbances of Vision.*—Disturbances of vision are rarely observed during pregnancy, but inquiries should always be made and the patient



cautioned concerning their diagnostic significance if they appear. Amaurosis or total blindness occurring at this time is generally due to albuminuric retinitis, and the first indication of a serious renal affection is sometimes afforded by an ophthalmoscopic examination.

**Diseases of the Blood.**—*Pernicious Anæmia.*—According to Osler, this complication was first described by Channing in 1842. Since then a considerable literature has accumulated upon the subject, which is well reviewed in Findley's article. The disease occasionally appears during pregnancy, but most frequently not until after labor. It is characterized by marked pallor and anæmia, which are associated with weakness and shortness of breath, the extremities also becoming œdematous.

A positive diagnosis is made by the microscopical examination of the blood, when the number of red blood-cells is found to be markedly diminished. Many of the corpuscles are irregular in shape, while nucleated varieties are not infrequently observed. At the same time there is a relative increase in the amount of hæmoglobin, though its total amount is considerably below normal. As a rule, the disease ends in death if not properly treated, and marked fatty degeneration of the various organs is found at autopsy. Excellent results are obtained by the administration of Fowler's solution in increasing doses, beginning with 5 drops 3 times a day.

*Leukæmia.*—Leukæmia is a very rare complication of pregnancy, Herman and H. Schroeder being able to collect from the literature only 8 and 10 examples, respectively. In 4 cases the disease had existed before the onset of pregnancy, while in the remainder it appeared after its inception. It exerts no direct effect upon gestation, though the association of the two conditions may seriously affect the mother. In several instances premature labor resulted, after which the symptoms underwent marked amelioration.

The diagnosis is rendered probable by the existence of marked anæmia associated with enlargement of the spleen, and is placed beyond doubt by a differential blood count. Examinations of the foetal blood by Säger, Cameron, and Laubenberg indicate that the characteristic leukocytes are not transmitted to the foetus. In view of the good results which sometimes follow spontaneous premature labor, pregnancy may be terminated artificially in serious cases.

*Hæmophilia.*—Although the existence of a hæmophilic diathesis may be without effect upon gestation, in the third stage of labor it predisposes to obstinate post-partum hæmorrhage. In view of this danger, in the rare cases in which the conditions are associated, Kehrer recommended the induction of abortion, though it is probable that the bleeding would be as difficult to check after that operation as after full-term labor. In a case of extra-uterine pregnancy under my observation hæmophilia proved a most serious complication at the time of operation.

*Lead Poisoning.*—C. Paul studied the histories of 141 pregnancies occurring in women suffering from chronic lead poisoning, and found that 86 ended in abortion or premature labor. Moreover, a large number of the children which were born alive perished at an early period, only 10 per cent. remaining alive at the tenth year. There is no doubt that the



lead is transmitted through the placenta, as in a premature child examined by Lewin 16 per cent. of the total weight of the liver was due to it. Frongea states that lead poisoning not only leads to abortion or premature labor, but is a potent cause of sterility; as in the lead works of Sardinia 20 per cent. of the married women are sterile, and an additional 23 per cent. have only one child.

**Diseases of the Skin.**—*Impetigo Herpetiformis.*—Hebra was the first to call attention to the serious nature of this disease, which occurs almost exclusively in pregnant or puerperal women, and is characterized by superficial pustules, which are arranged in groups or clusters with inflammatory bases. New lesions appear on the borders of older and crusted confluent patches, while recovery takes place in their centers. The lesions occur on the trunk, thighs, and in the neighborhood of the genitalia, but rarely upon the face. They are accompanied by itching and constitutional symptoms, chills and high fever. The recorded mortality is about 75 per cent., Debreuhl having collected 24 cases occurring in Austria and Germany with 18 deaths. The disease, as a rule, does not lead to abortion or premature labor, and many of the women affected with it died undelivered. According to Scheuer, it is toxæmic and not bacterial in origin. The treatment is purely palliative, but in view of the serious prognosis it may be advisable to adopt Mayer's suggestion and inject into a vein small quantities of blood serum obtained from normal pregnant women.

*Herpes Gestationis.*—This disease, more frequently known as dermatitis herpetiformis, is an inflammatory, superficially seated, multiform, herpetiform eruption, which is characterized by erythematous, vesicular, pustular, and bullous lesions. It occurs occasionally in pregnant women, and is accompanied by marked burning and itching. It pursues a chronic course, is often attended with fever, and sometimes ends in death.

Dühring believes that it is probably toxæmic in origin, though similar lesions sometimes occur during the course of sepsis. In view of its depressing character, the patient should be placed upon tonic treatment, while the itching is best allayed by the use of ointments or lotions containing oil of cade, carbolic acid, or similar substances.

*Pruritus.*—Itching is often a distressing complication of pregnancy. It may extend over the greater part of the body or be limited to the genitalia. General pruritus should be regarded as a neurosis, which is probably toxæmic in origin. It often gives rise to intense suffering, the itching sometimes being so constant that the patient is unable to sleep. In some patients the loss of rest and the nervous strain attendant upon it exert a marked influence upon the general condition. Such cases are best controlled by the administration of nerve sedatives and general tonic treatment. A rigid milk diet is sometimes followed by excellent results. When the condition is not amenable to treatment and the patient shows marked signs of exhaustion, the termination of pregnancy may be justifiable.

Genital pruritus—*pruritus vulvæ*—may be due to several causes, among which are irritating vaginal discharges, parasites or glycosuria. When due to the first-named cause, the condition is best treated by the administration of astringent vaginal douches and the maintenance of absolute



cleanliness. At the same time the itching may be allayed by the employment of ointments containing cocaine, menthol, or carbolic acid. Pruritus of diabetic origin is observed but rarely, but the possibility of its occurrence should always be borne in mind and the urine examined. If sugar is present, relief can be obtained only by placing the patient upon a rigid anti-diabetic diet, while at the same time the appropriate ointments should be employed. Occasionally intense itching about the anus may be due to the presence of seat-worms, which are best destroyed by the use of rectal enemata of infusion of quassia. If local measures prove ineffectual, a dose of 5 grains of santonin at night, followed by Rochelle salts the next morning, will often bring about the desired result.

*Abnormalities of Pigmentation.*—During pregnancy abnormalities in pigmentation are not infrequently noted, which are particularly marked along the linea alba and about the breasts. In other cases unsightly yellowish splotches—*cloasma*—appear upon the face. They are not amenable to treatment, but usually disappear promptly after childbirth.

*Hæmatoma of the Abdominal Walls.*—Stoeckel has reported two cases of hæmatoma of the abdominal walls occurring during pregnancy. In one case the tumor was situated in the sheath of the right rectus muscle just above the symphysis, while in the other it appeared as a large mass in the right hypogastric region, which was mistaken for the head of the child. The condition resulted from rupture of the inferior and superior epigastric artery respectively.

*Relaxation of the Pelvic Joints.*—Owing to the great vascularity incident to pregnancy, the various pelvic joints always show a somewhat increased motility. Occasionally, however, the softening of the interarticular cartilage at the symphysis pubis admits of such abnormal motion in the joint as to interfere seriously with the comfort of the patient, who suffers from intense dragging pains in the pelvis and lower abdomen; while at the same time the gait may be so profoundly altered as to suggest the existence of cerebral or spinal trouble. In such cases the application of a tightly fitting bandage about the thighs is followed by marked improvement, though occasionally the symptoms are so pronounced that the patient is obliged to take to her bed. The condition usually disappears spontaneously during the course of the puerperium, but in exceptional instances it may persist and give rise to such great discomfort that it may become necessary to “wire” the joint.

Similar relaxation may involve the sacro-iliac joints and cause great suffering. Particular attention has been directed to its frequency and significance by Goldthwait and Osgood. In many instances great relief may be afforded by applying adhesive strips, which extend outward from the posterior surface of the sacrum to the external portion of the thighs.

*Accidents during Pregnancy.*—The pregnant woman is exposed to the same possibility of injury as at other times, the prognosis not being materially altered except that abortion frequently occurs. Pregnancy itself may be complicated by accidents which are incident to that condition, the most important being rupture of an extra-uterine pregnancy, rupture of the uterus, and premature separation of the placenta—all very serious com-



plications. Their mode of production and treatment will be considered in detail in the appropriate chapters.

**Surgical Operations during Pregnancy.**—Formerly it was believed that the performance of surgical operations during pregnancy would almost inevitably bring about abortion or premature labor, even the extraction of a tooth being considered a serious procedure. At present, however, thanks to anaesthesia and a perfected surgical technique, many operations can be performed at this time with but little additional risk. Accordingly, whenever a condition arises in the pregnant woman which imperatively demands surgical treatment, the necessary operation should be performed without hesitation. At the same time, if the indication is not pressing, it is advisable to defer interference until after delivery, so as not to subject the patient to an added strain.

A review of the literature goes to show that amputations are not more dangerous than at other times. Several observers, notably Polk and Cragin, have removed the kidney without terminating pregnancy, and numerous cases are on record in which paranephritic or broad-ligament abscesses have been opened. Tumors of the generative tract can likewise be excised without great risk or markedly increasing the danger of premature labor. These conditions are considered in the chapter upon the Complication of Pregnancy by Diseases and Abnormalities of the Generative Tract.

**Appendicitis.**—Appendicitis probably occurs as frequently during pregnancy as at other times, but until recently it was comparatively overlooked, in great part, no doubt, because of the difficulty of diagnosis. Renvall in 1908 recorded 25 personal cases, and collected 253 cases from the literature.

It should be regarded as a very serious complication, as many women die if not operated upon, while the surgical procedures undertaken for its relief are frequently followed by premature labor.

Pregnancy does not predispose to its occurrence, but in cases of chronic disease in which the appendix has become adherent to the appendages or uterus exacerbation may result from the traction exerted by the enlarging organ. Moreover, when the process has eventuated in abscess formation, the rapid decrease in the size of the uterus following delivery may readily bring about rupture of the abscess walls.

The symptoms do not differ from those observed in non-pregnant women, but the condition is frequently overlooked, as the pains are often considered as being due to the pregnancy itself, while the distention of the abdominal walls by the enlarged uterus makes difficult the appreciation of the rigidity and muscle-spasm, which are usually valuable diagnostic aids.

One should always consider the possibility of appendicitis when a pregnant woman complains of pain in the right side of the abdomen, associated with an elevation of temperature and pulse, provided some more satisfactory explanation for the condition cannot be found. It should, however, be remembered that pyelitis or inflammatory conditions of the appendages may give rise to identical symptoms. At the time of labor and during the puerperium its recognition is still more difficult, and many

women have died from perforative peritonitis with the diagnosis of puerperal infection.

Operation is indicated in all cases in the early months. Later in pregnancy the presence of the enlarged uterus renders it difficult to expose the parts satisfactorily, and may seriously interfere with proper drainage should it prove necessary. In view of this difficulty, it has been suggested that the uterus be emptied by *accouchement forcé* before opening the abdomen. I, however, do not believe that it is necessary, and am convinced that its general adoption will add to the gravity of the operation. In the early months abortion is not likely to occur, provided the uterus has not been subjected to much manipulation; in the latter months premature labor is frequently observed, particularly in cases of abscess formation. It may be due to one of several factors—manipulation of the uterus, fever, and, when an abscess has formed, to the direct transmission of bacteria from it to the foetus.

*Intestinal Obstruction.*—This rare complication of pregnancy should be treated upon general surgical principles. I have seen two cases. In the first intussusception occurred at the site of a tubercular ulcer, and death followed resection of the gut; while in the second case obstruction was due to constriction by a peritoneal adhesion in a case of tubercular peritonitis. This was relieved by operation, and the patient was delivered at term, but died some weeks later from miliary tuberculosis.

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## CHAPTER XXVI

### THE TOXÆMIAS OF PREGNANCY

Fortunately, in the vast majority of cases gestation pursues a perfectly physiological course and is not attended by untoward symptoms. At the same time, there is no other condition in which the border-line between health and disease is less sharply marked, since a very slight irregularity often suffices to convert a physiological and normal into a pathological and abnormal state.

The general metabolism becomes profoundly modified during gestation, as is shown by the fact that during its later months the pregnant woman stores up nitrogen and water to a far greater extent than at other times, so that it would appear that her internal "housekeeping" is conducted upon much more economical lines than formerly. Moreover, it is probable that the excretory functions are more liable to serious derangement, since they are called upon to care for the elimination of the waste products of the foetal as well as the maternal organism. For this reason many women, who are perfectly well at other times, may suffer from the retention of certain metabolic products.

Formerly it was believed that the retention of such substances gave rise to abnormalities in the function of the liver and kidneys, and led to the production of the condition which we now designate as pre-eclampsic toxæmia, or even eclampsia. Following the statement of Bouchard that all pregnant women suffer to a greater or lesser extent from auto-intoxication, certain French observers, notably Pinard and Bouffe de Saint-Blaise, advanced the supposition that practically all of the abnormal manifestations of pregnancy rest upon such a basis, and that such mild conditions as slight headache, salivation, or certain skin eruptions, on the one hand, and such a serious disease as eclampsia on the other, represent, respectively, the early and the advanced stages of one and the same process, which they designated as hepato-toxæmia. Veit held that all of the disturbances of pregnancy result from cytolytic processes following the entrance of chorionic tissue and foetal ectoderm into the maternal circulation. Moreover, Stone, Strauss, Ewing, and others teach that albuminuria, vomiting of pregnancy, yellow atrophy of the liver, and eclampsia are all manifestations of disturbed metabolism, and should be grouped together under the common heading of toxæmia of pregnancy.

As the result of my investigations, I am convinced that such views are ~~now~~ <sup>now</sup> and only render more difficult the appreciation of the several ~~points~~ <sup>points</sup> concerning which our knowledge is still very fragmentary and ~~is~~ <sup>is</sup>. Chemical analysis of the urine, as well as the histological study ~~is~~ <sup>is</sup> obtained at autopsy, clearly indicates that essential and charac-

teristic differences exist between the various conditions thus grouped together; and I believe that the probability of the eventual discovery of their ultimate causes will be greatly increased by considering them separately, and at the same time candidly admitting that we are just beginning to realize our profound ignorance of the subject.

Moreover, it should be borne in mind that totally different pathological conditions may be accompanied by identical clinical manifestations, so that a proper classification cannot be based upon the occurrence of such symptoms as albuminuria, fever, coma, or convulsions, but must depend upon our ability to isolate certain specific poisonous principles, or to demonstrate distinctive pathological lesions. Unfortunately, the former is as yet out of the question, but the latter has already been accomplished along certain lines. We shall therefore consider separately the following groups of "toxæmia of pregnancy:" (a) Pernicious vomiting; (b) acute yellow atrophy of the liver; (c) nephritic toxæmia; (d) pre-eclamptic toxæmia; (e) eclampsia; (f) presumable toxæmias.

### PERNICIOUS VOMITING OF PREGNANCY

We have already referred to the ordinary type of nausea and vomiting, which is noted in the early weeks of gestation. This occurs in one third to one half of all pregnant women, usually appearing at about the sixth week, and disappearing spontaneously six or eight weeks later. In such circumstances the patient suffers from nausea, or even vomits shortly after arising, whence the term "morning sickness." In other cases the vomiting occurs at more frequent intervals, and occasionally lasts for a longer period, while exceptionally it continues throughout the entire pregnancy.

Ordinarily, such vomiting is attended by no more serious results than the actual discomfort connected with it, and many women consider it so natural an accompaniment of pregnancy that they do not complain of it. Others, however, soon demand relief from the physician, and the mere enumeration of some of the many remedies recommended affords conclusive evidence that a specific cure has not yet been discovered. In some instances the first remedy administered is followed by immediate relief, while in other cases various drugs may be employed in succession without result. Relief sometimes follows the administration before each meal of a capsule consisting of 2 grains of pepsin and  $\frac{1}{4}$  grain nitrate of silver. Oxalate of cerium in 5-grain capsules, or as an effervescent preparation, dilute tincture of iodine, dilute hydrocyanic acid, cocaine, or bismuth are also recommended.

In my hands, however, drugs are rarely required, except for the relief of constipation, and the condition can usually be cured, or at least greatly ameliorated, by suggestion, the adoption of more hygienic methods of living, and regulation of the diet. The physician should not make light of the condition, but he should impress upon the patient that vomiting is not a necessary accompaniment of pregnancy, as is shown by the fact that considerably less than one half of all pregnant women suffer from it, and furthermore that it can be controlled by exercise of the will, and the adop-



tion of suitable hygienic and dietetic measures. He should then inquire carefully into her mode of life, and see that proper exercise, occupation, amusement, and rest are obtained. The diet should be carefully regulated. I lay great stress, particularly on account of its suggestive influence, upon the patient eating a hard dry biscuit, such as one uses with cheese, the moment she awakens and before raising her head from the pillow. Afterwards breakfast may be taken in bed, or not, according to her habit. The important point, however, is to arrange that food be taken at frequent intervals throughout the day, so that the patient gets six small meals instead of three larger ones. It is not sufficient to prescribe this in general terms, but precise directions should be given as to exactly what should be eaten at definitely appointed hours. If the patient be impressed with the necessity of following these minutiae implicitly, the condition will usually pass off within a few days and the employment of drugs will be unnecessary.

Occasionally, the vomiting becomes more frequent and severe, so that in extreme cases no nutriment of any kind, not excepting water, can be retained. The condition is then known as pernicious vomiting, which, unlike the ordinary morning sickness, is extremely serious, and sometimes leads to a fatal issue, no matter how treated.

According to Pick and Lwow, pernicious vomiting occurs about once in every thousand pregnant women, but as their statistics are based upon hospital work they give no clue as to its incidence in private practice. Among the neurotic women of the upper classes in this country and France, I believe that it is encountered once in every several hundred pregnancies, but it appears to be less frequent in England and Germany.

**Ætiology.**—Until comparatively recently our knowledge concerning the nature of the affection was extremely defective, and even now our information is not entirely satisfactory. In my monograph, which appeared in 1906, I stated that the evidence then available justified the differentiation of three types of serious vomiting, namely, reflex, neurotic, and toxæmic. At present, although I believe that a toxæmic element is the underlying factor in all varieties, as well as in the ordinary morning sickness, I hold that the same terminology should be employed; as, in reflex and neurotic vomiting, the toxæmia seems to act merely as a predisposing cause and usually gives no trouble after the anatomical or neurotic condition is overcome or removed.

The reflex variety, as the name implies, results from the presence of structural abnormalities in other portions of the body, and particularly in the generative tract. Thus, it is sometimes associated with retroflexion of the uterus, an ovarian tumor, or some other lesion of the generative organs, and immediate relief may follow the replacement of the uterus, the removal of the tumor, or the correction of the abnormality. I must, however, confess that with more extended experience I believe less and less in the reflex factor, and am inclined to attribute to suggestion many of the cures which appear to follow its correction or removal.

Attention was particularly directed to the neurotic variety by Kaltenbach, who stated in 1891 that the vomiting of pregnancy is usually a



manifestation of a neurosis, somewhat allied to hysteria, and is readily amenable to suggestive treatment. Clinical observation affords abundant evidence in favor of such a view, as it is well known that many women, who are apparently on the verge of death from starvation as the result of vomiting, suddenly become better spontaneously following a threat to induce abortion. Moreover, prompt cure sometimes follows the mere administration of an anæsthetic, or the employment of the most varied and unscientific methods of treatment, such as the use of an electrical battery, which is entirely out of order, or the application of leeches or of various medicaments to the cervix. Furthermore, it may be safely assumed that the cures following dilatation of the cervix, as recommended by Copeman, are in reality due to suggestion.

In the true toxæmic variety, on the other hand, the reflex and neurotic elements are absent, and the condition is associated with a profound disturbance of metabolism, which is manifested by striking changes in the urine, and in fatal cases by the presence of definite lesions in the liver and kidneys. It was first shown in my clinic that the urine in such cases presents a high ammonia coefficient, indicating that a much larger proportion of the total nitrogen is excreted in the form of ammonia than usual, while Ewing believes that the same may be said of the "undetermined or rest" nitrogen. Normally, during pregnancy the ammonia coefficient varies between 4 and 5 per cent., but in toxæmic vomiting it may rise to great heights—from 20 to 50 per cent. (Figs. 446 and 447.) While I do not believe that such an occurrence is pathognomonic, as will be indicated below, it undoubtedly indicates a profound perversion of metabolism, which must be associated with grave danger to the patient.

Matthews Duncan in 1879 pointed out that the condition was sometimes associated with serious hepatic lesions, but this was not generally recognized until the work of Stone, Ewing, and myself showed that in many of the fatal cases lesions were present in the liver identical with those occurring in acute yellow atrophy. In such cases there is profound necrosis of the central portion of the lobules, while the periphery remains intact, and in one of my specimens the destruction of tissue was so great that practically nine-tenths of the entire organ was thrown out of function (Fig. 444). In other cases, the necrosis is absent, but the entire liver has undergone marked fatty degeneration, so that upon staining fresh sections with Sudan red practically the entire specimen seems to be filled with fat. Winter, Hofbauer and Czyzewicz, and many others have described similar changes. The renal lesions are degenerative in character, and are practically limited to the convoluted tubules, whose epithelium in many cases is necrotic and whose lumina are filled with débris. As a rule, the renal changes occur only in the terminal stages of the disease.

As the hepatic lesions are absolutely different from those observed in eclampsia, in which the process is essentially one of thrombosis and begins in the periportal spaces, I hold that toxæmic vomiting is an entirely distinct process, and that the two diseases have only two points in common, namely, that both occur in pregnant women and are manifestations of disturbed metabolism. It should not, however, be believed that the essential



process in the former consists in the lesions just described, but rather in the underlying toxæmia to which they are due. Furthermore, while it is probable that the extensive destruction of liver tissue may account for a part of the urinary changes, by so interfering with the intermediary stages of proteid metabolism that ammonia and other incompletely oxidized substances are excreted instead of urea, I am inclined to hold that the greater part of the change is dependent upon the underlying toxæmia, concerning whose nature we are as yet ignorant.

These views have not gone unchallenged, as Longridge, Leathes, and others urge that the high ammonia coefficient is simply a manifestation of an acidosis; Underhill and Rand consider it merely an accompaniment of inanition and in no way connected with a toxæmic process; while Whipple and Sperry and others suggest that the hepatic and renal lesions may result from poisoning by the chloroform used at the induction of abortion. The high standing of such critics entitles them to consideration, and I admit that their views are partially correct, but at the same time I contend that they are not of universal application, and by no means invalidate the conclusions I have drawn.

There is no doubt that pregnant women, just as other individuals, suffer from acidosis from various causes, which will naturally be accompanied by a high ammonia coefficient. Such an admission, however, does not indicate that a high ammonia coefficient in women suffering from pernicious vomiting is always susceptible to such an explanation. That this is not the case is shown by the fact that in many instances I have found that the employment of copious rectal enemata of sodium bicarbonate, and in one instance even its intravenous administration, had no effect upon the ammonia coefficient nor upon the reaction of the urine, which would have been materially altered were we dealing with a mere acidosis.

Furthermore, I am perfectly willing to admit that an acidosis incident to starvation may be accompanied by a high ammonia coefficient, and Fig. 447 gives an illustration in point. On the other hand, I contend that all cases presenting a high ammonia coefficient are not of this character. That this is so, is clearly illustrated by the history of the patient whose urinary analysis is represented in Fig. 446. In this instance no food had been taken for some time prior to the induction of abortion, nor for several days afterward, and yet the ammonia coefficient fell from 33 per cent. to practically normal, while the inanition still continued. It seems to me that the only explanation for such an occurrence is that the high ammonia was a manifestation of a toxæmia, which ceased as soon as the pregnancy which caused it was ended.

Likewise, the fact that one of my patients died several days after the vomiting had ceased, and while taking a satisfactory quantity of nutriment, would indicate that starvation is not the only factor concerned. In other cases the appearance of jaundice or the findings at autopsy would point to a similar conclusion; as no one contends that such conditions are ordinary manifestations of inanition.

Finally, I am quite prepared to admit that the liver lesions may result from chloroform poisoning if that drug were used as an anæ-

thetic when the abortion was induced. But when similar lesions are observed when ether or nitrous oxide are employed, and more particularly in patients who die before an attempt at abortion has been made, it is evident that in such cases the lesions must be due to some other factor.

After making all of these allowances and admissions, I have no hesitation in stating that there is abundant evidence to prove that certain cases

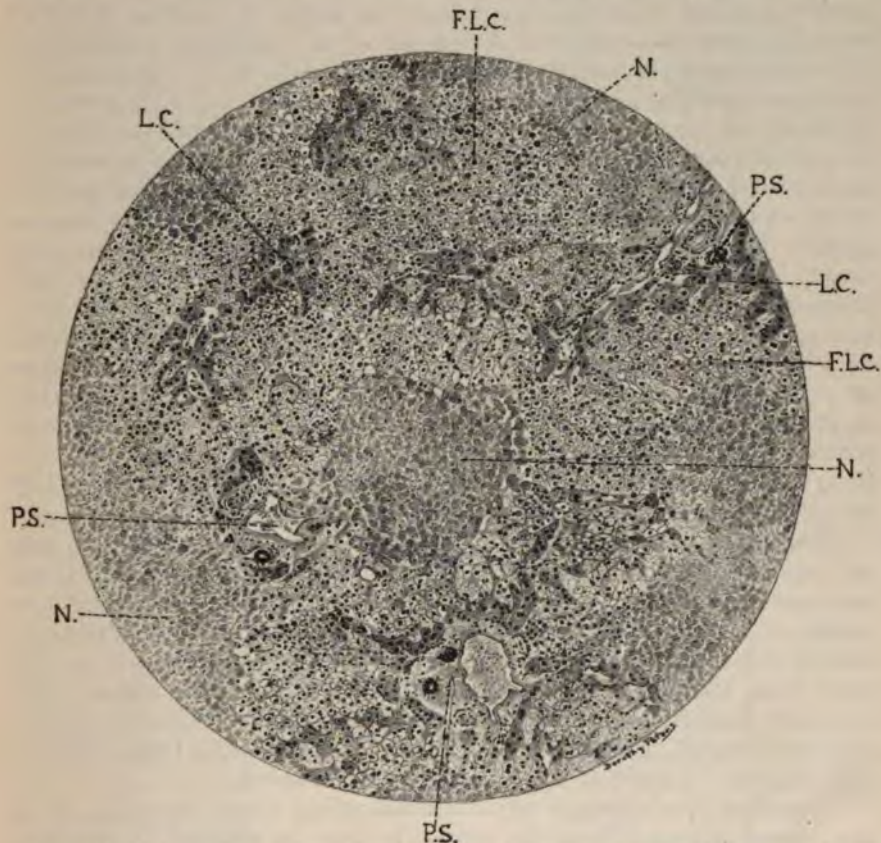


FIG. 444.—LIVER FROM VOMITING OF PREGNANCY SHOWING CENTRAL NECROSIS.  $\times 50$ .  
*F. L. C.*, liver cells showing fatty degeneration; *L. C.*, unchanged liver cells; *N.*, areas of necrosis; *P. S.*, portal space.

of pernicious vomiting are due to a toxæmia, which is associated with a high ammonia coefficient, a marked reduction in the output of urea, and with profound degenerative lesions in the liver and kidneys.

**Symptoms.**—Ordinarily, pernicious vomiting begins as the simple nausea and vomiting of pregnancy, which gradually becomes so frequent and severe that nothing can be retained by the stomach. Unfortunately, the mere severity of this symptom gives no clue as to whether one has to deal with the neurotic or toxæmic type. In the former the vomiting may continue for weeks, and the patient gradually becomes more and more



emaciated, and eventually dies of starvation if suitable treatment be not instituted.

Toxæmic vomiting may occur in either an acute or chronic form. In the former the disease pursues a rapid course, and the patient, after a few days of ordinary vomiting, may begin to eject coffee-ground vomitus, soon passes into a somnolent or comatose condition, and dies within a week or ten days without emaciation. In the latter, and much more frequent, variety constant vomiting may persist for weeks, the patient becoming markedly emaciated before the seriousness of the condition is appreciated. Then she begins to vomit coffee-ground-like material, which she rejects in large quantities and without apparent effort. At this time symptoms indicative of toxæmia appear, the patient becoming torpid or violently excited and soon passes into a condition of coma, which is occasionally accompanied by convulsions. In some instances slight jaundice may develop, and, toward the terminal stage of the disease, the urine becomes greatly diminished in amount, and contains albumin, casts, and even blood. Formerly it was taught that in the later stages of the disease fever frequently occurred, and was associated with a rapid and thready pulse and pronounced albuminuria. This, however, has not been my experience, as fever was absent in all of my fatal cases. The behavior of the pulse is not constant—in some cases it soon becomes rapid and thready, while in others it is scarcely accelerated. Several of my patients have recovered with a pulse of 120 or over, while in a fatal case it did not exceed 96. For these reasons, I cannot accept Pinard's dictum that abortion should always be induced whenever the pulse rate continues higher than 100.

# **Diagnosis.**—Acute toxæmic vomiting is readily recognized, but from my experience it is impossible by a single clinical examination to diagnose the chronic variety. Thus, it may happen that two women may appear to be equally ill and to present the same degree of inanition, yet careful examination will show that one is suffering from neurotic and the other from toxæmic vomiting, and the former will recover within a few days after suggestive treatment, while the latter may die even after abortion has been induced. For these reasons it is highly important that a differential diagnosis be made at the earliest possible moment.

Accordingly, a thorough physical examination should be made, and if any serious abnormality of the generative tract be detected, it should at once be corrected on the assumption that one has to deal with reflex vomiting. On the other hand, if no lesion can be detected, the diagnosis lies between the neurotic and toxæmic types; but, unfortunately, a positive diagnosis is not always easy. Great help may be obtained by determining the ammonia coefficient; namely, the ratio of the nitrogen contained in the ammonia to the total nitrogen content of the urine. Normally, this varies between 3 and 5 per cent., but under pathological conditions it may rise as high as 30, 40, or even 50 per cent. Unfortunately, such investigations cannot be made by the physician in his office, but require the services of a trained chemist, as they necessitate the determination of the total quantity of nitrogen and of the ammonia by the methods of Kjeldahl and Folin, respectively.

In my monograph I stated that a normal ammonia coefficient indicated neurotic, and one exceeding 10 per cent. toxæmic vomiting. Unfor-

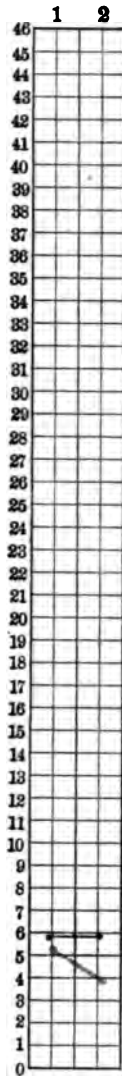


**FIG. 445.—URINARY CHART, NEUROTIC VOMITING.**  
In this and the following charts each square corresponds to 1 gram of nitrogen and 1% of ammonia. Total Nitrogen: Black. Ammonia: Red.

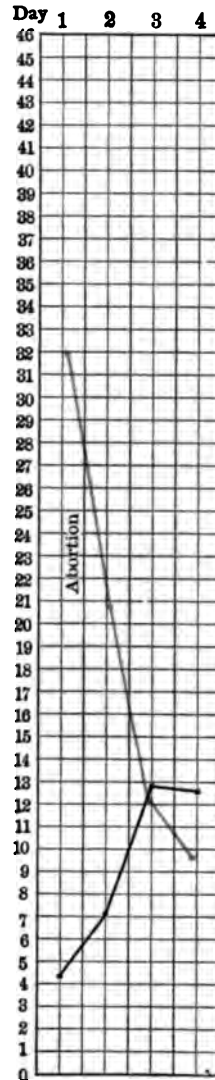


**FIG. 446.—URINARY CHART, TOXÆMIC VOMITING, RECOVERY AFTER INDUCED ABORTION.**  
Total Nitrogen: Black. Ammonia: Red.

tunately the matter is not quite so simple, as increased experience has taught me that a high ammonia coefficient may be due to the inanition accompanying prolonged neurotic vomiting, as well as to the perverted



metabolism characterizing the purely toxæmic type. Notwithstanding these qualifications, such determinations are of great value. If the ammonia

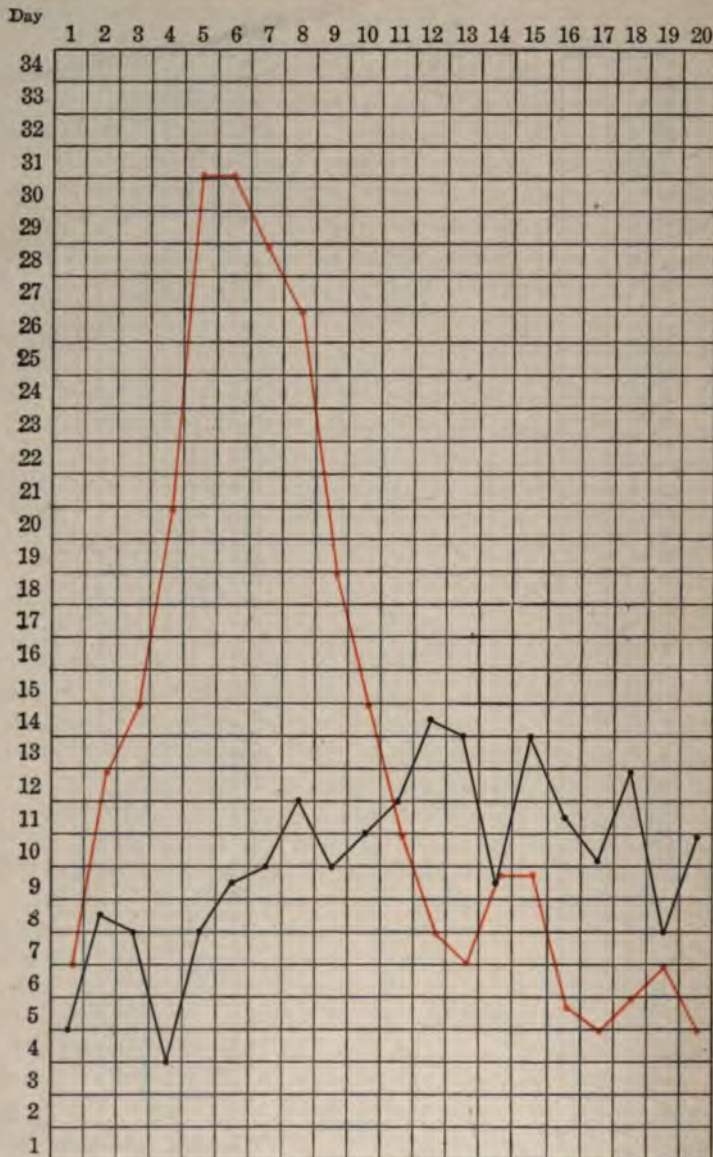


FIG. 447.—URINARY CHART, NEUROTIC VOMITING WITH STARVATION.  
Cure by suggestion and forced feeding. Grams Total Nitrogen: Black. Percentage Ammonia Coefficient: Red.

coefficient is 5 per cent. or less, the vomiting is neurotic in character, can be controlled by rest in bed and suggestion, and never requires the induction of abortion. On the other hand, a high ammonia does not

necessarily predicate the existence of toxæmic vomiting; but when it exceeds 15 or 20 per cent. it clearly indicates that the patient is seriously ill. In such cases a differential diagnosis can usually be made by carefully watching the patient. If the coefficient falls after a few days' rest in bed, energetic rectal feeding, and moral suasion, a diagnosis of neurotic vomiting is permissible; but if the coefficient remains stationary or rises, one probably

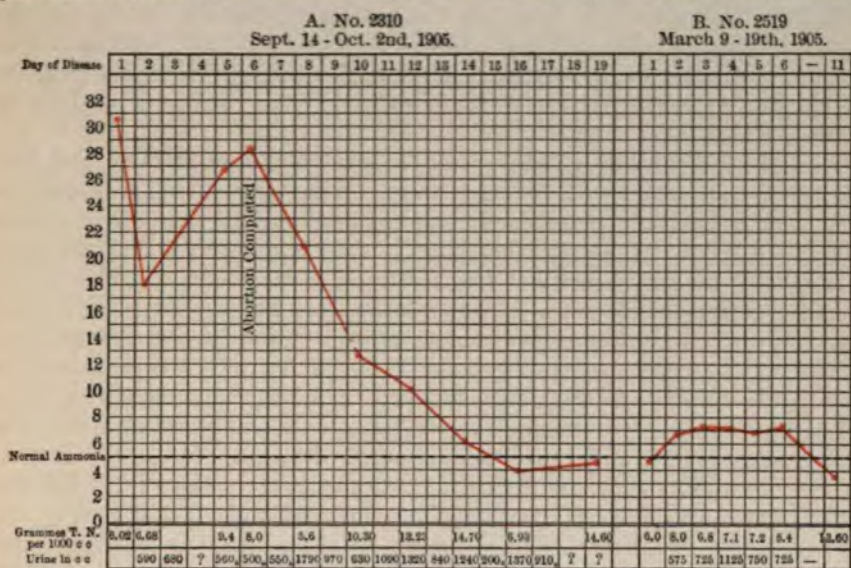


FIG. 448.—CHART SHOWING AMMONIA COEFFICIENT IN TWO CONSECUTIVE PREGNANCIES. A, toxæmic, and B, neurotic vomiting.

has to deal with the toxæmic variety, and the diagnosis becomes absolute if torpor, coma, or coffee-ground vomit appear.

**Prognosis.**—The prognosis is extremely satisfactory in the reflex and neurotic varieties. In the former relief promptly follows the correction of the genital abnormality, while in the latter cure can usually be effected within two or three days by suggestive treatment, provided the physician is sufficiently sure of himself to be able to impress his belief upon the patient. On the other hand, the prognosis is always grave in the toxæmic variety, as we have no means of determining to what extent the internal lesions have progressed, or whether it is possible for them to undergo repair, even if the underlying cause of the toxæmia be removed by terminating the pregnancy. In any event, it should be remembered that a certain proportion of such cases will die no matter what may be done.

Pernicious vomiting sometimes recurs, and many women suffer repeatedly from the neurotic variety in succeeding pregnancies. Unfortunately this may also occur in the toxæmic variety, though the mere recurrence of vomiting in a subsequent pregnancy does not necessarily indicate that one has to deal with the same type, as I have seen several patients who suffered from toxæmic vomiting in the first pregnancy, and from the neurotic variety in the second (Fig. 448).



**Treatment.**—Formerly the treatment of pernicious vomiting was very unsatisfactory. This was in great part due to the fact that in the neurotic variety cures sometimes occurred when the patient was almost *in extremis*, so that the physician usually deferred inducing abortion in the hope that such an outcome might occur in his case. Consequently, when it was determined to interfere, the patient was usually so ill that death was inevitable, no matter what was done. The recognition, however, of the several types of vomiting just described affords valuable information as to the treatment to be pursued, and indicates that abortion is sometimes performed unnecessarily in neurotic, and frequently deferred too long in toxæmic vomiting.

In the reflex variety, the displaced uterus should be replaced and held in position by a properly fitting pessary, or the ovarian tumor should be removed, as the case may be. In the neurotic variety the patient should be put to bed and kept from her family as far as possible. She should be assured by the physician that her condition is not serious, and will not require active interference. At the same time she should receive large amounts of saline or one per cent. glucose solution by the rectum, and occasional nutrient enemata, but for a day or so no attempt should be made to administer nourishment by mouth. After a few days' rest, however, small quantities of fluid nourishment should be administered at frequent intervals, and the patient assured that her condition will pass off within a short time. Ordinarily, if the physician is sure of himself and possesses the absolute confidence of the patient, this result will usually follow; but in exceptional instances more radical treatment is necessary, and an absolute rest cure should be insisted upon. In such cases the patient should be isolated from her family, and placed in a well-conducted hospital in the hands of a competent and trusted nurse. In such conditions, the *régime* just indicated will bring about the entire disappearance of symptoms within a few days.

In the toxæmic variety, on the other hand, prompt induction of abortion is the treatment *par excellence*, and should be performed as soon as the diagnosis is made. On account of the possibility of chloroform still further damaging the liver, anæsthesia should be induced by means of ether or nitrous oxide, and the uterus emptied by the most conservative method: vaginal hysterotomy if the cervix is rigid, or dilatation by means of Goodell's or Hegar's dilators if it be soft and patulous. Following the operation the patient should be given copious saline rectal enemata, and for a short time, at least, the administration of food should be regarded as a matter of secondary importance. Great relief is sometimes obtained by gastric lavage and leaving 500 cubic centimeters of a 1-per-cent. solution of sodium bicarbonate in the stomach.

#### ACUTE YELLOW ATROPHY OF THE LIVER

This condition, which has been variously designated as icterus gravis, typhoid icterus, etc., is a rare but very serious complication of pregnancy. Kerkring in 1706 was the first to report a fatal case in a pregnant woman,

but since then every one who has studied the disease has laid stress upon the association. Thus, Thierfelder found that 62 per cent. of the 143 cases which he collected from the literature had occurred in pregnant women, while Quincke placed the incidence at 60 per cent.

**Pathology.**—In acute yellow atrophy the liver rapidly diminishes in weight, which in a comparatively short time may be reduced to less than one half of the normal. Its capsule assumes a wrinkled appearance and the entire organ becomes softened. On section it varies from dark red to almost chrome yellow in color, and upon closer examination each lobule is seen to present a reddish center surrounded by a yellowish periphery.

The histological findings vary according to the severity of the disease. In mild cases the center of each lobule has undergone necrosis and the cells of the periphery present an almost normal appearance, while between the two is a thicker or thinner layer of cells presenting more or less advanced fatty degeneration. In other cases almost the entire parenchyma of each lobule is destroyed and is converted into a granular mass of necrotic *débris*, while about the periphery only an occasional well-preserved liver cell is seen; at the same time the interlobular spaces with their blood-vessels and biliary canals are but little changed. The kidneys present signs of acute nephritis and the epithelial cells lining the convoluted tubules are in all stages of degeneration, and in extreme cases are entirely necrotic, while the lumina are filled with casts and *débris*. On the other hand, the glomeruli and the cells lining the collecting tubules are but little changed.

Acute yellow atrophy of the liver may occur at any period of pregnancy, Beatty and Masson having described cases at the sixth and eighth weeks respectively. Usually, however, it appears during the later months of pregnancy or in the first days of the puerperium.

**Symptoms.**—In acute cases the symptoms may come on so suddenly as to arouse a suspicion of poisoning, and in some instances the condition has been mistaken for phosphorus or some other form of poisoning. Thus it may happen that a woman, who previously was in apparently perfect health, may be seized with pains in the abdomen, intense headache, and possibly severe vomiting and purging. In a short time she becomes torpid or violently delirious and soon passes into a condition of coma, which may or may not be disturbed by convulsions. In most cases the coma continues for a few hours or days until death supervenes, but recovery may occasionally occur. There is generally a certain amount of jaundice, which may vary from a mere discoloration of the conjunctivæ to pronounced general icterus. The vomited matter is frequently blood-stained, and sometimes assumes a coffee-ground appearance. The urine is diminished in amount, very high-colored, and contains albumin, all varieties of casts, and frequently large quantities of blood.

The symptoms are identical whether the condition occurs during pregnancy or the puerperium, and, if convulsions appear, it is usually mistaken for eclampsia. In other cases the course of the disease is less rapid, and in its early stages may simulate an ordinary pre-eclamptic toxæmia. Slight jaundice, however, soon appears, and the patient gradually becomes more and more apathetic and torpid, and eventually passes into a condi-



tion of coma, which usually terminates in death. In this class of cases the diminution in the size of the liver may be traced by percussion, and in one of my patients the area of hepatic dulness became diminished by more than one half in the course of a week. Spontaneous birth of a dead child is not unusual.

Chemical examination of the urine shows changes analogous with those already described in toxæmic vomiting, and similar to those observed in acute phosphorus poisoning. The total nitrogen may or may not be diminished, but its partition always presents marked changes, the urea being always diminished and the ammonia coefficient greatly elevated. Moreover, there is a marked increase in the amino acids, and crystals of leucin and tyrosin may be demonstrated by appropriate procedures.

It is evident that, just as in toxæmic vomiting, the underlying factor in the production of acute yellow atrophy of the liver must be a profound toxæmia, concerning whose origin we are as yet absolutely ignorant. Likewise, the changes in the liver and kidneys must be regarded as secondary to it, and not as the primary manifestation of the disease.

**Diagnosis.**—The diagnosis cannot always be made from the clinical manifestations, and as already indicated the condition is frequently mistaken for eclampsia, although the appearance of jaundice should always be suggestive. On the other hand, the pronounced changes in the urine should lead to a positive diagnosis; but in the absence of a thorough chemical examination it is possible only at autopsy. The prognosis is always bad, the possibility of recovery depending upon the extent of the organic lesions; and as this cannot be determined during life, one should be most cautious in expressing a hope of recovery.

**Treatment.**—If the condition occurs during pregnancy, the uterus should be emptied as rapidly as is consistent with the safety of the patient, and the various excretory organs stimulated, as will be described under eclampsia. During the puerperium the latter is the only treatment available.

### NEPHRITIC TOXÆMIA

This condition, as its name implies, is associated with primary lesions of the kidneys and is usually noted in women who were suffering from chronic nephritis prior to pregnancy, or in whom an acute process originates during that period, and should be regarded as analogous with the so-called uræmic poisoning. I also believe that it is the underlying factor in women who repeatedly give birth to premature infants and present a history of being perfectly well up to a certain period of pregnancy, when cedema and albuminuria suddenly develop. In such cases, the urinary symptoms may persist for some months after delivery, but eventually disappear, to reappear at about the same period in each subsequent pregnancy. This condition differs markedly from the pre-eclamptic toxæmia, and is explicable by assuming that the individual has slightly defective kidneys, which are efficient under ordinary conditions, but break down under the strain of pregnancy. Fortunately nephritic toxæmia is not of very fre-

quent occurrence, though it should be feared in women suffering from chronic nephritis.

**Symptoms.**—The condition may appear at any period of pregnancy, but most frequently in its later months. It is usually accompanied by lassitude, general malaise, headache, and marked œdema, and occasionally by the ocular symptoms associated with albuminuric retinitis. In other cases, however, the patient may complain of little except œdema, and with the exception of the urinary changes, which will be described below, may appear but slightly sick, yet nevertheless she may suddenly pass into a condition of coma which may be accompanied by convulsions, and either die or slowly recover. In the more chronic forms of this variety of toxæmia both red and white infarcts are frequently noted in the placenta, and occasionally occupy so great a part of it as to interfere seriously with its function; as a result the child, whose vitality is already seriously impaired by the toxæmia, is imperfectly nourished and frequently dies. Indeed, it may be said that, with the exception of syphilis, chronic nephritis is the most common cause of spontaneous premature labor.

**Diagnosis.**—In many instances it is impossible to differentiate this form of toxæmia from the ordinary pre-eclamptic variety, although the urinary findings are sometimes strikingly different. In the former the quantity of urine may be normal or even increased, although large amounts of albumin and casts are present. The total nitrogen, the urea, and the ammonia coefficient are usually unchanged, though when the latter falls much below the usual limits it frequently indicates that a uræmic attack is impending. In pre-eclamptic toxæmia, on the other hand, the output of urine is usually decreased, and the total nitrogen and urea correspondingly diminished. In doubtful cases a hint as to the true condition may occasionally be gained by studying the catalytic activity of the blood. Winternitz and Ainley in my service found that the reaction is usually abnormally low in cases of pure renal insufficiency, but normal in pre-eclamptic toxæmia and eclampsia.

If the patient is not seen until after the onset of convulsions and coma, the condition is usually mistaken for eclampsia. After delivery, if the urine rapidly clears up, it may be assumed that one had to deal with eclampsia; while if albuminuria and casts persist for months a probable diagnosis of renal insufficiency should be made. In many instances, however, one remains uncertain as to the nature of the attack unless the patient dies and comes to autopsy.

X **Prognosis.**—Provided convulsions and coma do not appear, the prognosis in this variety of toxæmia is good, so far as the immediate life of the mother is concerned, but in view of the frequency of placental lesions the possibility of the premature birth of a dead child should always be considered. Naturally the ultimate prognosis is bad, as the strain of pregnancy usually accentuates the original nephritic process.

**Treatment.**—The treatment is identical with that which will be laid down for pre-eclamptic toxæmia, while if convulsions or coma occur it is along the same general lines as for eclampsia.



## PRE-ECLAMPTIC TOXÆMIA

This is the most frequent variety of toxæmia of pregnancy, and for many years was considered as its sole representative. It occurs several times in every one hundred pregnancies, and is more frequent in primigravidae than in women who have borne several children. Fortunately it is usually readily amenable to treatment, though if neglected, and occasionally even notwithstanding the most rational treatment, it may terminate in eclampsia.

**Symptoms.**—Pre-eclamptic toxæmia usually appears in the latter part of the second half of pregnancy, and occurs but rarely in its early months. It should be suspected whenever the patient complains of headache, lassitude, or œdema, and particularly if the urine is diminished in amount or contains albumin. The symptoms vary from slight malaise to those indicative of profound auto-intoxication. In this event the patient may complain of severe and persistent headache, violent epigastric pain, or visual disturbances which may vary from slightly impaired vision to complete amaurosis. In many cases the ophthalmoscope may reveal the characteristic lesions of albuminuric retinitis; but when they are absent, the derangement of vision must be attributed to degenerative changes in the higher nervous centers. Now and again the patient may suffer from hallucinations, and border on the verge of insanity. In rare instances the woman may pass into a somnolent condition, which gradually deepens into coma, usually followed by death; but more commonly typical eclampsia supervenes. When the toxæmia is pronounced, even though it does not eventuate in eclampsia, the child may suffer, and not a few cases terminate in the spontaneous expulsion of a dead premature foetus.

The total amount of urine may be greatly diminished, and sometimes falls as low as 200 to 300 cubic centimeters in the twenty-four hours. It contains a variable quantity of albumin, numerous casts, and in severe cases blood cells. Chemical examination gives varying results, according to the gravity of the toxæmia. In mild cases the amount of total nitrogen and the relative proportion of its various constituents is but little changed, but in more pronounced cases there is a considerable diminution in the total nitrogen, with a decrease in the percentage of urea and of sodium chloride, associated with a slight increase in the amount of ammonia and the amino acids.

**Diagnosis.**—The clinical differentiation between the nephritic and pre-eclamptic types of toxæmia is not always easy, and is considered in the preceding section, but in the absence of a definite history of pre-existing nephritis it is sometimes impossible. Fortunately, the difficulty in diagnosis is of more importance from a scientific than from a practical point of view, as the treatment to be employed is identical in both cases. When Geraghty and Roundtree pointed out the value of phenol-sulphone-phthalein in testing the functional activity of the kidneys, it was hoped it might prove useful in this condition, but the observations of Goldsborough upon normal pregnant women in my clinic showed that conclusions based upon it should be taken with great reserve.

**Prognosis.**—The prognosis in pre-eclamptic toxæmia is usually fair, but it is entirely dependent upon the amenability of the symptoms to treatment. If marked improvement does not occur, premature labor should be induced in the hope of preventing the onset of eclampsia. Even in severe cases the nitrogenous constituents of the urine assume their normal relations within a few days after spontaneous or induced labor, while the albuminous content may persist for weeks before gradually disappearing. Chronic renal disease rarely results from this type of toxæmia, and it is my experience that it is unusual for it to recur in succeeding pregnancies. This, of course, is not a universal rule, but it would appear that one attack confers a relative immunity upon the patient, just as in eclampsia. Accordingly, when toxæmia occurs in repeated pregnancies it may be inferred that it is of the nephritic type and is dependent upon the existence of a chronic nephritis.

**Treatment.**—In the chapter upon The Management of Pregnancy attention was directed to the necessity for the frequent and routine examination of the urine for the purpose of recognizing this condition, and of preventing the development of eclampsia by suitable treatment. Even in normal cases these examinations should be made once in four weeks during the first six months, and every two weeks during the last three months of pregnancy. The patient should also be cautioned to notify the physician whenever she suffers from headache, disturbance of vision, or œdema.

If the presence of albumin is detected, or the physician does not feel satisfied with the condition of the patient, the entire amount of urine passed in the twenty-four hours should be measured, and the output of albumin, as well as the total amount of nitrogen, determined and its partition studied. Unfortunately this is practicable only where the services of trained chemists are available, but in general practice approximate results may be obtained by the use of Esbach's albuminometer and Doremus's ureometer, and, as the urine contains but small amounts of ammonia, such estimations are far more reliable than in toxæmic vomiting and acute yellow atrophy of the liver. For practical purposes the amount of total nitrogen may be approximately estimated by dividing the urea reading by two.

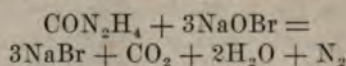
Esbach's albuminometer is a graduated test-tube provided with a stopper (Fig. 449), in which the albuminous substances are precipitated by a solution consisting of picric acid 10, citric acid 20, and distilled water 1,000 grams. In order to make the determination, the tube is filled to the mark U with urine and afterward to R with the reagent. It is then corked and gently inverted ten or twelve times, after which it is allowed to stand for twenty-four hours, when the amount of precipitate is read off on the scale, each division corresponding to 1 gram of albumin to the liter, or one tenth of one per cent.



FIG. 449.—ESBACH'S ALBUMINOMETER.



Doremus's ureometer, which is represented in Fig. 450, enables one to estimate indirectly the amount of urea after decomposing it by means of sodium hypobromite, the reaction being shown by the following formula:



The potassium bromide and carbon dioxide are dissolved, while the nitrogen gas rises to the top of the tube, where it can be measured. Each division on the scale indicates the presence of 0.001 gram of urea to each cubic centimeter of urine.



FIG. 450.—DOREMUS'S UREOMETER.

Ordinarily, if the urea output is normal (16 to 24 grams *per diem*), the presence of a slight amount of albumin may be regarded with indifference; whereas, if a considerable quantity is present—5 grams or more to the liter—and the urea at the same time falls below 10 grams, the patient should be regarded as in serious danger and should be kept under close supervision. During this time the twenty-four-hour specimen of urine should be examined daily, and the treatment based upon the relative amounts of albumin and urea present, as well as upon the subjective symptoms. (See Fig. 451.) The sudden appearance of amaurosis, and more particularly of pain in the epigastrium, should always be regarded with suspicion, as it is frequently the precursor of eclampsia, and the same may be said of a sudden increase in the blood pressure,

which sometimes rises as high as 200 or more millimeters. If the total nitrogen and its partition be determined, a rise in the ammonia coefficient should be considered as favorable.

The patient should be put to bed, or at least confined to her room and placed upon a restricted diet, meats and the coarser vegetables being interdicted; or, better still, for a while she should depend solely upon milk, which is not only an excellent food, but also a most efficient diuretic. At least two quarts should be consumed in the twenty-four hours. To relieve the monotony, she may be allowed small quantities of lettuce salad, bread and butter, and occasionally a little herring roe as a relish. She should also be made to take large quantities of fluid in the shape of plain water, lithia water, or cream of tartar lemonade (1 dram to the pint).

In most cases such treatment will be followed by a marked amelioration of the symptoms, an increased urinary secretion, a decrease in the amount of albumin, a rise in the amount of urea, a decreased blood pressure, and a prompt return to normal conditions (Fig. 451). If the desired result is not promptly obtained, a brisk purge of Rochelle or Epsom salts should

be given, and the cutaneous functions stimulated by a hot pack or sweat bath. If under treatment the symptoms disappear, the albumin becomes less and the urea increased in amount, the outlook may be considered excellent. On the other hand, if the albumin steadily increases, and the urea decreases in amount, while the subjective condition of the patient remains unchanged or becomes more serious, the prognosis becomes

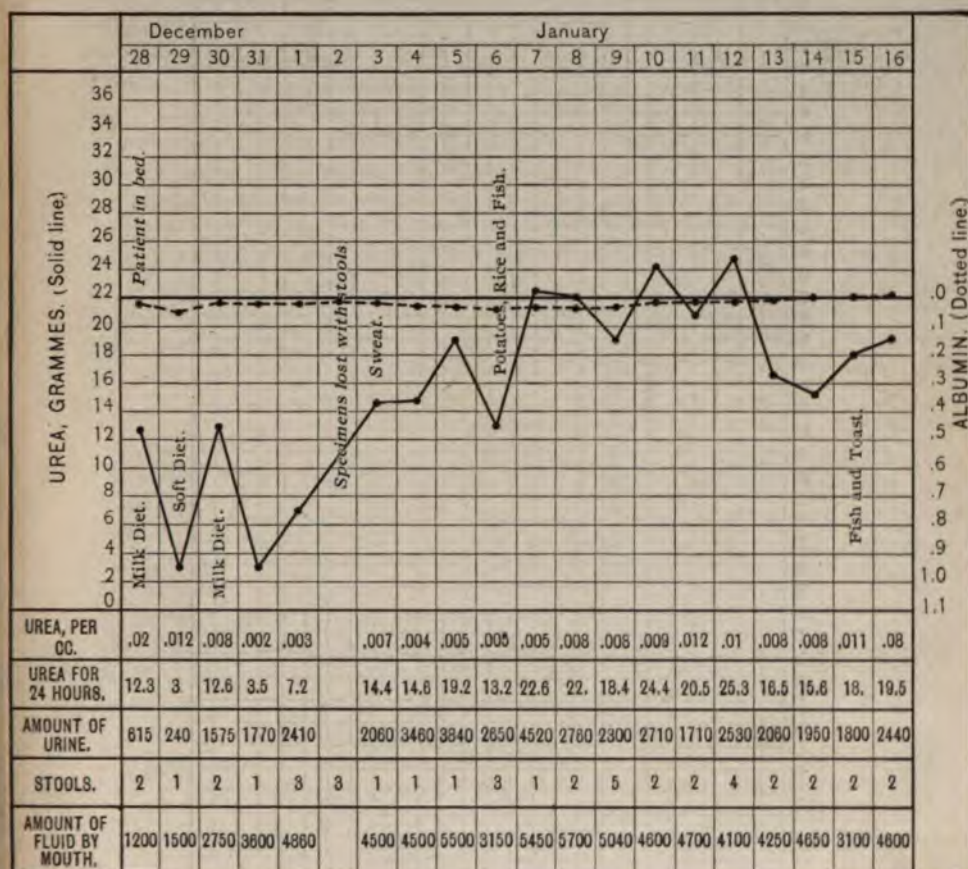


FIG. 451.—URINARY CHART.

Pre-eclamptic toxæmia; recovery under milk diet and rest in bed.

ominous, and the appearance of somnolence and coma or eclampsia can probably be avoided only by emptying the uterus, no matter what be the period of pregnancy. In my experience, an output of 8 to 10 grams of albumin per liter, irrespective of other symptoms, justifies interference. If haste is not essential, this is easiest effected by the introduction of a bougie, but if the indications are urgent the uterus should be emptied by vaginal hysterotomy, unless the cervix be so soft, and its canal so obliterated, that manual dilatation by Harris's method can be safely effected.



Unfortunately, we are not yet acquainted with the actual toxic agent or agents concerned in the production of this variety of toxæmia or of eclamp-

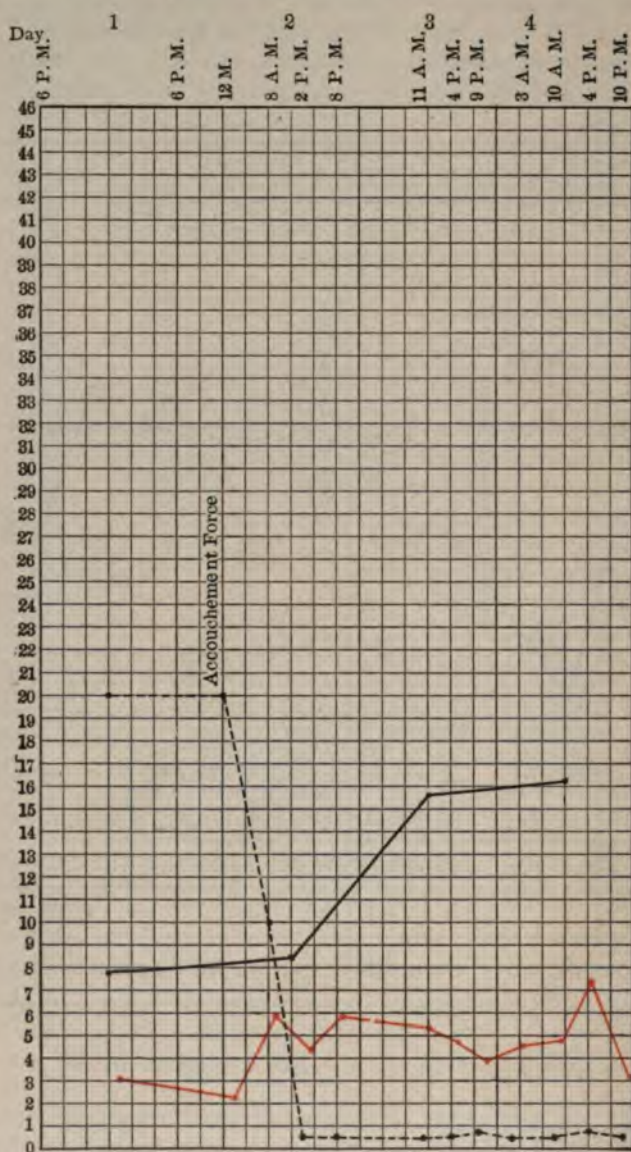


FIG. 452.—URINARY CHART. PRE-ECLAMPTIC TOXÆMIA, RECOVERY AFTER ACCOUCHEMENT FORCE.

Total Nitrogen ——— Ammonia: Red. Albumin - - - - -

(Each square corresponds to 1 gram of nitrogen, 1% of ammonia, and  $\frac{1}{10}$ % of albumin.)

sia, and consequently the indications for interference are only relative. Thus, it sometimes happens that the urinary findings and clinical symp-

toms so improve under treatment that one is inclined to feel that all danger has passed, nevertheless eclampsia suddenly supervenes. On the other hand, one occasionally feels that the induction of labor is imperatively demanded, but after deferring it for some reason, the patient may unexpectedly make a most satisfactory recovery without any untoward manifestation. Such experiences indicate that our knowledge of the subject is far from complete; but at present all that is possible is to follow the directions just given, and to interfere whenever the urinary findings and clinical symptoms indicate that the condition is serious. By so doing, it is possible that premature labor may occasionally be induced unnecessarily; but, on the other hand, many more patients will be saved from the dangers of eclampsia, as the prompt recognition and conscientious treatment of pre-eclamptic toxæmia constitutes our only available means of preventing this dreaded disease.

Some authorities go as far as to hold that such prophylaxis is absolute, and that the occurrence of eclampsia indicates neglect on the part of the physician. No doubt this is usually the case, but the rule is not without exceptions; as upon several occasions I have seen eclampsia occur in women awaiting delivery in my wards, where the urine had been negative only the day before the outbreak of convulsions.

### ECLAMPSIA

Eclampsia is an acute toxæmia occurring in the pregnant, parturient, or puerperal woman, and is usually accompanied by clonic and tonic convulsions, during which there is loss of consciousness followed by more or less prolonged coma. Generally, convulsions and eclampsia are considered as synonymous terms, but such a view is not correct, inasmuch as a number of well-authenticated cases of eclampsia without convulsions have been recorded, and other toxæmic conditions occasionally occur in obstetrical practice which are likewise accompanied by convulsions or coma. Accordingly, the only absolutely characteristic feature of the disease is the presence of the hepatic lesions which will be described later.

**Frequency.**—Statistical tables go to show that eclampsia occurs about once in every 500 labors, but it is almost impossible to determine its incidence with any degree of exactness, inasmuch as few practitioners see a sufficiently comprehensive series of cases in private practice to permit of trustworthy conclusions, while, on the other hand, hospital records by themselves give an exaggerated idea of its frequency, for the reason that many of the patients would have remained at home had they not had convulsions. The following table would indicate that eclampsia occurs in about 1.0 per cent. of the women entering lying-in hospitals.

|                              |                   |                       |           |
|------------------------------|-------------------|-----------------------|-----------|
| Goldberg (Dresden, 1891)     | in 10,717 labors, | 81 cases of eclampsia | (0.75%)   |
| Cassamayor (Paris, 1892)     | “ 16,225 “        | 99 “                  | “ (0.61%) |
| Knapp (Prag, 1900)           | “ 7,636 “         | 41 “                  | “ (0.53%) |
| Newell (Boston, 1900)        | “ 6,700 “         | 99 “                  | “ (1.17%) |
| Reinburg (Paris, 1905)       | “ 26,511 “        | 90 “                  | “ (0.34%) |
| Lichtenstein (Leipzig, 1911) | “ 14,836 “        | 400 “                 | “ (2.68%) |
| Williams (Baltimore, 1912)   | “ 11,000 “        | 110 “                 | “ (1.0%)  |



The larger tabulations made by Veit in 1896, which are based upon statistics from the various clinics in Germany, show that 905 cases of eclampsia occurred in 149,366 labors—a percentage of 0.6, or 1 in 166. These statistics include all cases of eclampsia, but Lichtenstein differentiated between the total number of cases and those occurring in patients who were in the hospital at the onset of the disorder, and found that in the latter the ratio was only 0.15 per cent., or 1 in 600.

Eclampsia varies markedly in frequency at different times, Cassamayor stating that in Tarnier's clinic in Paris it was observed many times more frequently in some years than in others. Thus, in 1872, there was 1 case to every 47 labors, as compared with 1 to 730 and 1 to 130 in the years 1882 and 1891, respectively.

**Clinical History.**—Zweifel has reported a case of eclampsia occurring in the third month, but as a rule it is not encountered before the second half of pregnancy, and becomes more frequent the nearer term is approached.

It is generally stated that 70 to 80 per cent. of all cases occur in primiparous women, Knapp, Olshausen, Cassamayor, and Goldberg reporting a proportion of 71, 75, 77, and 86.4 per cent. respectively. In all probability these figures are somewhat too high, inasmuch as they are based upon hospital practice. Nevertheless, be this as it may, it is certain that in the main primiparous women are much more liable to the disorder.

Twin pregnancy and hydramnios appear to act as predisposing factors, the former condition being noted by Olshausen and Cassamayor in 8 and 5.7 per cent. of their cases of eclampsia respectively, whereas for all labors the usual ratio is 1.5 per cent. It is possible that heredity sometimes plays a part in its production, and Elliot, Olshausen, and Pinard have reported cases which apparently confirm this view.

An eclamptic convulsion sometimes occurs without warning, "like a bolt from a clear sky," in women who were apparently in perfect health. In the vast majority of cases, however, the outbreak is preceded for a longer or shorter period by premonitory symptoms indicative of pre-eclamptic toxæmia. The attack may come on at any time, sometimes while the patient is sleeping. If she is awake, the first sign of the impending convulsion is a fixed expression of the eyes, which soon begin to roll from side to side. The pupils are usually dilated, less often contracted. The convulsive movements appear first about the mouth, which begins to twitch and is drawn to one side, the entire face becoming distorted. They extend rapidly to the arms, the body, and, finally, to the legs. They are usually tonic in character, though sometimes they take on a tonic form and the patient becomes rigid. The breathing is stertorous, the face congested and the patient foams at the mouth, and often bites her tongue. During the convulsion, which may last for a few seconds to two minutes, the woman is completely unconscious, and after the movements cease passes into a state of coma which lasts for a longer or shorter period.

When particularly when the disorder appears in the latter part of labor or during the puerperium, a single convulsion only may be observed. However, the first is the forerunner of other convulsions, which may number from 1 or 2 in mild, to 10 or 20 or even 100 or more



in severe cases, the intervals between them becoming shorter in inverse proportion to the number. In rare instances they follow one another so rapidly that the patient appears to be in a prolonged, almost continuous convulsion.

The duration of the coma is very variable. When the convulsions are infrequent, the patient usually recovers consciousness after each attack, while in severe cases the coma persists from one convulsion to another, and death may result without any awakening from it. In rare instances a single convulsion may be followed by profound coma, from which the patient never emerges, though, as a rule, death does not occur until after a frequent repetition of the convulsive attacks. The immediate cause of death is usually oedema of the lungs or apoplexy, though if the fatal issue is postponed for several days, it is usually attributable to an aspiration pneumonia or a puerperal infection.

In most cases during the seizure the arterial pressure is markedly increased, and may reach 240 or 260 mm., while the pulse is full and bounding. In severe cases, however, it is weaker and more rapid, becoming more compressible and filiform with each succeeding convulsion. In some cases the temperature rises to a very considerable height from the onset of the disease and rapidly falls as the patient improves; more often, however, it remains normal. A temperature of 104 or 105 degrees is not unusual, and in one of my fatal cases it reached 109.5 degrees just before the end. As regards the cause of this elevation there is much discrepancy of opinion. Olshausen believes that the poison which gives rise to the eclampsia also stimulates the thermal centers, while Zweifel holds that the fever is nearly always of infectious origin. I incline toward the former view, for the reason that the uterine lochia were always sterile whenever I made a bacteriological examination in patients presenting a transient elevation of temperature. On the other hand, the fever is practically always infectious in origin if it persists for more than 24 hours after the cessation of the seizures, and it would seem that women suffering from the disease are more susceptible to infection than usual.

While the convulsions are by far the most striking clinical manifestations of eclampsia, and even give the disease its name, instances are occasionally met with in which they are absent, the patients dying in coma and presenting at autopsy the hepatic and renal lesions characteristic of the affection. Three such cases were reported by Schmorl in 1902, and I have seen two examples, which were recorded by Slemmons in 1907. Since then the condition has been more generally recognized, so that Schmid in 1911 was able to collect 24 cases from the literature. In many instances the absence of convulsive attacks has led to an erroneous clinical diagnosis, the condition having been regarded as uræmic coma, phosphorus poisoning, fulminating bacterial infection, Weil's disease, or acute yellow atrophy of the liver. In fact, a correct diagnosis can usually be established only at autopsy.

According as the disorder first appears before or during labor or in the first hours of the puerperium, it is designated as ante-partum, intra-partum, or post-partum eclampsia. It is generally stated in the text-books that the



last is the least common; but that the conclusions as to the relative incidence of the different varieties are by no means unanimous is shown by the following table:

|                    | ANTE-PARTUM. | INTRA-PARTUM. | POST-PARTUM. |
|--------------------|--------------|---------------|--------------|
| Olshausen .....    | 40%          | 46%           | 14%          |
| Knapp .....        | 24.5%        | 60.9%         | 14.6%        |
| Goldberg .....     | 26%          | 57%           | 17%          |
| Reinburg .....     | 49.5%        | 29.5%         | 20%          |
| Lichtenstein ..... | 21%          | 61.5%         | 17.5%        |
| Williams.....      | 55%          | 22%           | 23%          |

Newell and McPherson state that one third of their cases occurred after the birth of the child. Personally, I have observed an incidence of 23 per cent. for the post-partum variety.

It would appear from the statistics just cited that ante-partum eclampsia occurs less frequently than the intra-partum variety, but this does not correspond with my own experience. Olshausen has reached a similar conclusion, and considers that the contrary statements of most authors are due to the fact that they have failed to remember that eclampsia usually supervenes before the estimated end of pregnancy and that uterine contractions set in with the first convulsion, so that if the patient is not seen before the seizure it is often very difficult to determine with which variety one has to deal.

Ante-partum eclampsia may terminate in several ways. As a rule, labor sets in and a premature child is born spontaneously, or the uterus is emptied by operative procedures. Sometimes the patient dies undelivered. Lichtenstein has directed particular attention to the fact that labor does not always supervene, but that the woman may recover and give birth to a dead or macerated foetus some time afterwards, or may even go on to term and bear a living child. He has collected from the literature 56 examples of the former and 64 of the latter eventuality, and has pointed out that, while the death of the child in the first instance may account for the cure of the disease, such an explanation will not hold in the second instance, and renders it very questionable whether the life or death of the child has anything to do with its causation. Olshausen and others have described as recurrent eclampsia cases in which the patients, after being perfectly well for a longer or shorter period, have a recurrence of the seizure, which may terminate in any one of the ways mentioned above.

If the attack occurs during labor, the pains usually increase in frequency and severity, so that the child will be born somewhat sooner than usual, after which the convulsions generally cease. On the other hand, in severe cases, or when there is some impediment causing dystocia, the patient may die undelivered, unless operative measures are undertaken.

In post-partum eclampsia the attack usually comes on soon after delivery, and recovery often occurs after a single convulsion. In other cases, however, the seizures follow one another in rapid succession, and frequently cause death. The general belief that cases of this variety are comparatively benign is denied by Olshausen and Lichtenstein, who noted a mortality of 25 and 27 per cent., respectively.

A few instances have been reported in which convulsions did not appear until several weeks after the birth of the child. It can be safely assumed, as was pointed out by Van der Velde, that such conditions were not eclamptic at all, but are due to hysteria, uræmia, or other causes.

Occasionally the onset is preceded by a distinct aura (Olshausen), but this is usually lacking. In rare instances the convulsion comes on without warning, but it is generally preceded for some days or even weeks by symptoms indicative of pre-eclamptic toxæmia. As has been pointed out by Olshausen, severe epigastric pain is a frequent precursor of the seizure, and is a sign to which too much attention can hardly be paid.

The convulsions are always followed by unconsciousness. Moreover, the patient may not only not remember the attack itself, but even have no recollection of occurrences which had taken place several hours previous to it. This is a not altogether uncommon observation, and may sometimes have an important bearing from a medico-legal point of view.

In 5 per cent. of Löhlein's and in 7 per cent. of Lichtenstein's cases eclampsia was followed by marked mental derangement. In my own expe-

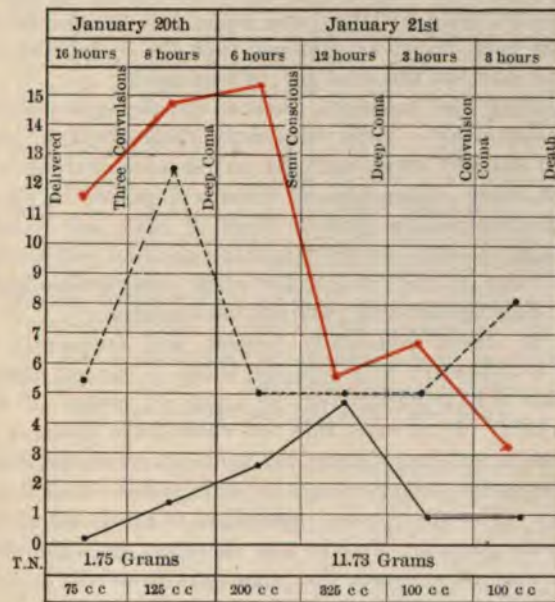


FIG. 453.—URINARY CHART. ECLAMPSIA, DEATH 48 HOURS AFTER ONSET.

Total Nitrogen ——— Ammonia: Red. Albumin ———

(Each specimen analyzed separately. Figures on left side indicate grams of nitrogen and percentage of ammonia; on right side, percentage of albumin.)

rience this complication has occurred much less frequently; although it must not be forgotten that psychosis following eclamptic convulsions is one of the well-recognized varieties of puerperal insanity; but whether it is a direct result of the disease or is due to a coincident infection has not yet been demonstrated.



## THE TOXEMIAS OF PREGNANCY

In rare instances, as the result of cerebral lesions incident to eclampsia, a hemiparesis may develop during the puerperium. A case of this character, occurring in one of my patients, was reported in detail by Woods at the 1902 meeting of the American Ophthalmological Society.

More frequently disturbed vision during the latter part of pregnancy is due to an albuminuric retinitis. As this is an accompaniment of an acute nephritis, eclampsia does not always develop, and the outcome is dependent upon the further course of the underlying disease. In other cases the visual disturbance is unattended by demonstrable changes in the retina or optic nerve, and is to be regarded merely as a manifestation of the general toxæmia, complete recovery usually following within a few days after the termination of pregnancy.

In a small number of cases the patient becomes markedly jaundiced, either during or shortly after the convulsive seizure. This sign is of grave prognostic significance, and indicates serious hepatic involvement.

Eclampsia may occur not only during the course of an ordinary gestation, but was observed by Maygrier in the false labor accompanying extra-uterine pregnancy. Falk, Sitzenfrey, and others have reported cases occurring in association with hydatidiform mole, and the possibility of such an occurrence has been urged as evidence that the metabolic processes of the fœtus play no part in the ætiology of eclampsia.

The urine during the eclamptic seizure usually gives evidence of a marked renal insufficiency. It is invariably diminished in amount and frequently almost entirely suppressed, as in the case charted in Fig. 453, in which only 75 cubic centimeters of urine was passed in sixteen hours. On microscopical examination various types of casts are found in great abundance, although the hyaline and granular varieties predominate. Epithelial casts also occur, as well as isolated renal cells, while blood is nearly always present. Hæmoglobinuria may also be observed.

Albuminuria is almost constantly present, and frequently is so pronounced that it is necessary to dilute the urine to several times its bulk before an accurate determination can be made by means of the Esbach tube. In the majority of my cases this test showed the presence of at least 10 grams of albumin per liter during the acute stage of the disease, while in many instances much larger quantities were noted—sometimes as high as 30 or 40 grams. The albuminous precipitate is composed of both serum albumin and serum globulin, and in one instance, in which the relative amounts of each were determined, the latter was found to be 34 per cent.

The high albumin output is only temporary. Usually it falls to a fraction of one gram per liter within 36 or 48 hours after delivery, and then rapidly disappears, though in other cases traces may be observed for weeks (Fig. 454). This rapid decrease was carefully studied by Emerson in one of my patients, specimens being taken at the time of convulsions, and at four-hour intervals during convalescence. During the eclamptic attack the urine contained 1.23 per cent. of albumin by weight, as compared with 0.25 per cent. twelve hours later. It is interesting to note that these high grades of albuminuria do not necessarily indicate profound renal lesions, as in several of my cases, in which the urine contained large

amounts of albumin, as well as quantities of casts, only a mild degenerative nephritis was found at autopsy.

The total nitrogen of the urine, estimated by the Kjeldahl method, is markedly diminished in eclampsia, and at the same time there occurs a profound alteration in the proportions of its various constituents. Thus

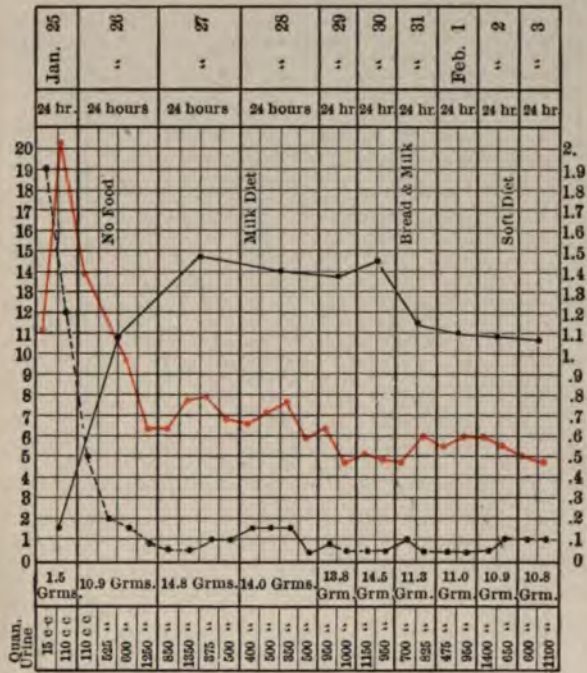


FIG. 454.—URINARY CHART. ECLAMPSIA WITH RECOVERY.  
Total Nitrogen ——— Ammonia: Red. Albumen ———  
(Figures on right and left as in Chart 453.)

the urea, which normally makes up about four fifths of the total, is reduced to less than one half. On the other hand, there is a relative increase in the amount of the amino acids and the various substances which are precipitated by phospho-tungstic acid, such as creatinin, uric acid, etc. The study of the behavior of the ammonia coefficient is of particular interest. With the onset of convulsions a decrease is usually observed (Fig. 455), which is soon followed by a marked rise, so that the ammonia coefficient usually remains relatively high for a variable length of time. In our experience this condition is of favorable import, as in several fatal cases the ammonia coefficient was low.

During convalescence the urine usually returns to a normal condition, but at the same time the increase in its quantity and nitrogenous content cannot be regarded as being entirely due to the elimination of materials, whose retention was supposed to have caused the disease. We now know that somewhat similar changes are observed after normal labor, when the



high nitrogenous content must be accounted for by the involution of the uterus and other puerperal changes. Although the albumin usually clears up rapidly, it frequently shows a slight increase when the patient is allowed a more liberal diet. On the other hand, its persistence for several months indicates the existence of a chronic nephritis, which in most cases antedated the eclamptic attack, but occasionally appears to have resulted from it.

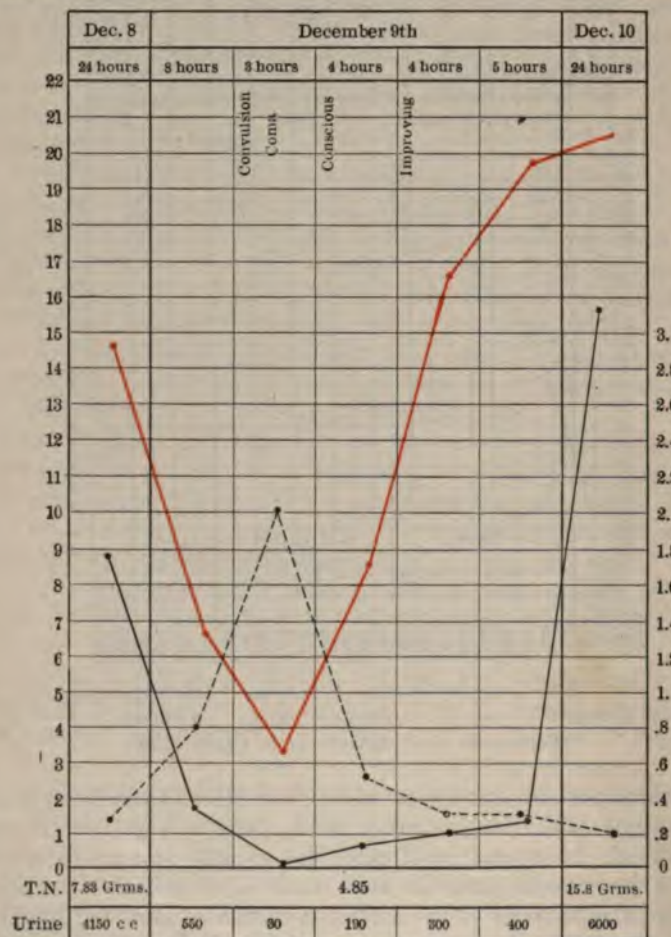


FIG. 455.—URINARY CHART. ECLAMPSIA WITH RECOVERY.  
 Total Nitrogen ——— Ammonia: Red. Albumin - - - - -  
 (First reading, day preceding attack. On day of attack, each specimen analyzed separately.  
 Figures on right and left as in Chart 453.)

**Pathology.**—After Rayer and Lever had demonstrated the presence of albumin in the urine of women suffering from this disorder, it was generally believed that the fundamental pathological lesion in eclampsia was a nephritis, and for a long time the condition was considered to be identical with uræmia.

This view, however, was gradually abandoned when it was found that

only a small proportion of the women suffering from chronic nephritis had eclampsia; and still further modifications became necessary after it had been shown that the urine did not necessarily contain albumin at the time of the eclamptic attack, Schroeder, Ingerslev, and Charpentier having collected respectively 62, 112, and 143 such cases from the literature. Its absence, however, does not necessarily disprove the renal origin of the disease, since Van der Velde has reported two instances of eclampsia in which the kidneys were markedly diseased, notwithstanding the fact that albumin was not demonstrable in the urine.

For the most part, autopsy will reveal the presence of renal changes, which may be very marked in some and only slight in other cases. The lesions are usually those of an acute nephritis with marked degeneration and necrosis of the renal epithelium. Ordinarily, this is the only renal lesion, though occasionally it may be engrafted upon a chronic process. Prutz found kidney changes in all but 7 out of 368 cases collected from the literature, in which the description was sufficiently accurate to be of value. Forms of acute or chronic nephritis were present in 46 and 11.6 per cent. of his cases respectively, while degenerative changes were observed more frequently. His conclusions are stated as follows: "Notwithstanding the frequency of renal lesions, we are not justified, even in the majority of cases, in considering them as the anatomical substratum of eclampsia, for in many instances they are too insignificant; accordingly, it must remain a question whether they are not purely secondary in the greater proportion of the cases." This view is also endorsed by Pollak and Bar. The former noted renal changes in 98.4 per cent. of 139 cases, and the latter in all of his 38 autopsies, but in approximately half the cases the lesion was very slight in character.

More or less similar results were obtained by Olshausen, Goldberg, Hughes and Carter, Lubarsch and Schmorl, all of whom stated that renal lesions were absent in a small proportion of their cases; although Bouffe de Saint Blaise states that these organs are often perfectly normal, and that lesions when present should be considered as secondary. On the other hand, Pels Leusden, Winckler, and Knapp observed pronounced renal changes in all of their cases, and were inclined to consider them as the characteristic lesion of the disease.

Guénard and Potocki attempted to determine the permeability of the kidneys by administering methylene blue to 7 eclamptic patients. As the drug could always be demonstrated in the urine a short time after its administration they concluded that the renal function was not markedly impaired, even though anatomical lesions might be present.

On the whole, the evidence at hand would seem to indicate that renal changes, while almost constantly present, are not, as a rule, sufficiently marked to justify one in considering them as the characteristic lesion of eclampsia, which must therefore be sought in some other organ.

Halbertsma, in 1876, pointed out that the ureters were often enlarged and dilated, and was inclined to attribute the production of the disease to this condition. Prutz noted a similar finding 37 times in his analysis of 500 autopsies, and Lichtenstein in 15 out of 50 autopsies.



In 1886 Jürgens and Klebs pointed out the existence of a *hæmorrhagic hepatitis* in certain cases of eclampsia. Their observations, however, created very little interest, and it remained for Pilliet, in 1888, to direct our attention to certain hæmorrhagic lesions in the eclamptic liver. His work was abundantly confirmed by Schmorl in 1893, who, in a monograph based upon 17 autopsies, stated that he had found in every case lesions of the liver which he held to be more characteristic than those observed in the



FIG. 456.—ECLAMPTIC LIVER.  $\times 50$ .

B. D., bile duct; C. V., central vein; N., periportal necroses.

kidneys. These consist of irregularly shaped, reddish or whitish areas scattered through the entire organ in the neighborhood of the smaller portal vessels. Ordinarily they are readily seen with the naked eye, and on section give the liver a mottled appearance. Under the microscope they are recognized as areas of necrosis, involving the periphery of the individual lobules and the portal spaces, in which blood-cells may or may not be present. Schmorl attributed their formation to degenerative changes following thrombotic processes in the smaller portal vessels, and considered

that their presence justified the diagnosis of eclampsia without further knowledge of the history of the case (Fig. 456). Flexner has shown that the earliest stages in the thrombotic process are due to the agglutination of red blood-corpuscles.

These findings were soon confirmed by Lubarsch, Prutz, Bar and Guyeisse, Bouffe de Saint Blaise, and many others; and Schmorl, in 1902, observed them in 71 out of 73 autopsies, while in the two negative cases there was a fresh thrombosis of the portal vein. I have been able to demonstrate similar lesions in all the eclamptic livers which I have examined, and consider that they are absolutely characteristic; since, as far as we know at present, they do not occur in any other disease; and Opie, in his article upon zonal necroses of the liver, takes a similar view. Konstanti-



FIG. 457.—PLACENTAL GIANT CELL AND CHORIONIC VILLUS IN BLOOD-VESSEL OF TUBE WALL SOME DISTANCE FROM PLACENTAL SITE.  $\times 80$ .

nowitsh reviewed the subject very thoroughly in 1907, basing his conclusions upon 30 specimens studied in Marchard's laboratory. While generally endorsing Schmorl's teaching, he holds that the initial change consists in the dilatation and thrombosis of the capillaries at the periphery of the lobules, which is followed by necrosis of the liver cells and an extension of the process to the portal spaces.

Several observers have described the presence of hæmatomata of varying size, just beneath the capsule of the liver, Prutz having recorded a fatal intra-peritoneal hæmorrhage from the rupture of such a structure.

Various statements have been made concerning the pathological findings in the brain—œdema, hyperæmia, anæmia, thrombosis, and apoplexy being described as the main lesions. Prutz noted œdema in 42 per cent., hyperæmia in 35 per cent., and apoplexy in 13 per cent., while the brain was apparently normal in only 10 per cent. of his cases. Schmorl, in 58



out of 65 autopsies, in which the organ was examined, noted the presence of thrombi in the smaller cerebral vessels, and regarded them as the cause of the small areas of necrosis which are so often observed.

In most cases of eclampsia the heart is more or less involved, and was perfectly normal in only 8 out of 102 autopsies analyzed by Pollak. According to Schmorl, the changes usually consist in degenerative processes in the myocardium, which are generally regarded as being due to eclampsia, though at times they may be attributed to the use of chloroform in its treatment.

Following Schmorl and Winckler, all investigators have demonstrated in the pulmonary capillaries the presence of giant cells, which they have identified with the so-called giant cells of the placenta—namely, masses of syncytium. Schmorl formerly believed that their presence probably explained the origin of the thrombotic processes observed in various organs. But at present they are regarded as having no significance, as they can always be found in pregnant women dead of other diseases.

In patients who have died several days after the cessation of the convulsions, in addition to the lesions just described, broncho-pneumonia or the various evidences of puerperal infection are frequently noted.

It is apparent, therefore, that the main lesions in eclampsia are found in the liver, kidneys, heart, and brain; but in view of the marked discrepancy in the statements of the various authors concerning their relative frequency and importance, it would seem, with the exception of the lesions in the liver, that the anatomical changes are not constant or characteristic. Accordingly, it must be assumed that the essential feature in the morbid process is the circulation of some as yet unknown toxic substance in the blood, which gives rise to lesions of varying intensity in the several organs.

**Ætiology.**—So many hypotheses have been advanced concerning the ætiology of eclampsia that Zweifel has aptly designated it as "the disease of theories." Unfortunately, exact knowledge is still lacking.

From the earliest periods it was considered as a disorder of the nervous system peculiar to pregnancy. This conception is no longer entertained, though there is no doubt that the nervous system is in a condition of far less stable equilibrium during pregnancy than at other times. This fact has been conclusively demonstrated by Blumreich and Zuntz, who showed that convulsions could be produced by the application of far smaller quantities of powdered creatinin to the cerebral cortex in pregnant than in non-pregnant animals.

Following the discovery by Lever that the urine of eclamptic patients contained albumin, the disease was identified with uræmia, and this view was only slowly abandoned after it had been conclusively demonstrated that the two conditions had but little in common.

Spiegelberg, in 1870, advanced the theory that the circulation of ammonium carbonate in the blood was responsible for the seizures, but, chemical analysis having failed to substantiate this statement, the idea was soon abandoned.

The Traube-Rosenstein theory, which held that the convulsions were the result of anæmia and œdema of the brain, found widespread accept-



ance for many years, but was ultimately abandoned in view of the fact that such conditions could not always be demonstrated at autopsy.

Délore and Rodet, of Lyons, in 1884 suggested bacterial invasion as a possible ætiological factor, but adduced no evidence in support of such a view. The first investigations were made by Doléris in 1885. Following him, a large number of observers reported that they had cultivated various bacteria from the blood, urine, and tissues of eclamptic women, but their results were so contradictory as to be of but little value. On the other hand, Haegler, Döderlein, Schmorl, Lubarsch, and Bar and Guyeisse obtained uniformly negative results, and, as my own experience has been similar, I feel justified in concluding that satisfactory proof has not been adduced in support of the bacterial nature of the disease, nor does it seem likely to be forthcoming.

A much more promising field of investigation was opened up by the work of Bouchard upon auto-intoxication. Rivière, in 1888, was the first to put forward the theory that eclampsia was an auto-intoxication resulting from the heaping up of some substance in the system during pregnancy, holding that its presence was indicated by an increase in the toxicity of the blood serum and a decrease in that of the urine.

This conception was placed upon an apparently solid foundation by the work of Chamberlent and Tarnier and their students, who showed that the urine of women suffering from eclampsia, or just about to be attacked by it, when injected into the circulation of animals was far less toxic than usual, while the toxicity of the blood serum was markedly increased. They concluded, therefore, that some poisonous substance, which should have been excreted by the kidneys, was accumulating in the system and increasing the toxicity of the blood serum, which in turn gave rise to the renal and hepatic lesions, thereby still further accentuating the condition.

Their investigations were apparently confirmed by the work of Ludwig and Savor, who considered the offending product to be carbamic acid, which they believed was formed as the result of imperfect metabolic processes, especially in the liver. The studies of Volhard in 1897 failed to substantiate these findings, as he was unable to show that the blood serum was more toxic in eclampsia than in other conditions.

Furthermore, the doctrine in general received a severe blow when the work of Van der Bergh, Forchheimer, Stewart, and Schumacher showed the results obtained by the injection of blood serum and urine into animals to be so variable and dependent upon so many factors that they must be received with the greatest caution. The experiments of the last named investigators proved that death depends in great part upon the rapidity with which the injection is made, as well as the fact that the toxicity of the urine is principally due to bacterial products rather than to a definite organic poison; since they found that large quantities could be injected into animals with impunity, provided it is thoroughly sterilized; whereas, if such precautions are not taken, small quantities of the urine led to uniformly fatal results. An even more potent argument against the acceptance of such experiments is the generally recognized fact that the injection of blood serum into an animal of another species is usually



followed by various biological reactions, such as agglutination, hæmolysis, etc. To overcome this difficulty, Semb immunized rabbits to normal human blood serum, and then injected into their circulation serum from eclamptic women. None of his animals had convulsions, but in many instances more or less characteristic lesions were found in the livers and kidneys. He believed that his experiments demonstrated an increased toxicity of eclamptic serum, but further investigations have not borne out his conclusions.

The most enthusiastic advocate of the doctrine that eclampsia is due to the heaping up of poisons in the blood are the students of Pinard. Thus, Bouffe de Saint Blaise considers that the essential feature of the disease consists in an alteration in the function of the liver, which fails to render innocuous certain poisonous products of metabolism, and that these in turn give rise to an auto-intoxication, or hepato-toxæmia. When the disturbance is slight, the patient merely suffers from nausea or headache; but when it is marked, secondary renal changes develop which in turn lead to a still further retention of the poison and the ultimate production of eclampsia.

Following the failure to demonstrate experimentally an increased toxicity of the blood serum, the ætiology of eclampsia has been extensively investigated and has given rise to a voluminous literature, which abounds in contradictions and has not led to generally accepted conclusions.

Generally speaking, the investigations have been undertaken in the hope of demonstrating that the disease is due to one or more of the following factors:

- I. Fœtal metabolism.
- II. The entrance of fœtal or placental elements into the maternal circulation.
- III. Poisoning by substances formed or retained in the placenta.
- IV. Disturbances of the maternal metabolism.
- V. Anaphylactic reaction.
- VI. Mammary toxæmia.

I. Fehling in 1899 and Dienst in 1902 advanced the theory that eclampsia was due to intoxication by certain products of fœtal metabolism, the maternal organism being unable to accommodate itself to the increased strain incident to their elimination. The advocates of this view lay great stress upon the fact that convulsions sometimes appear in the children of eclamptic mothers shortly after birth, and are accompanied by thrombotic changes, as well as by lesions in the liver and kidneys identical with those in the maternal organs. Observations of this character have been made by Schmorl, Chamberlent, Bar and Guyeisse, Knapp, myself, and others, and are considered critically in Dienst's monograph. Furthermore, the demonstration by Krönig and Füh, Zangemeister, Szili, and others that the osmotic pressure and electrical conductivity are identical in both maternal and fœtal blood indicates that there is no fundamental objection to the acceptance of such a theory.

This view also receives a certain amount of support from clinical expe-

rience, since, as is well known, the convulsions usually cease soon after delivery; while spontaneous recovery is the rule when the *fœtus* dies during pregnancy. Moreover, Baron and Castaigne have shown that the transmission to the mother of substances injected into the *fœtus* ceases almost immediately after its death.

On the other hand, observations of this character are not necessarily convincing; as it may be urged that recovery is due not so much to the delivery or death of the *fœtus* as to the coincident elimination of the maternal metabolic processes peculiar to pregnancy. Furthermore, several writers have contended that the association of eclampsia with hydatidiform mole affords conclusive evidence that the *fœtus* is in no way concerned. To my mind, however, this contention does not appear to be well founded, as it is quite conceivable that the metabolic processes incident to the continued growth of the chorionic epithelium may be practically identical with those of the normal *fœtus*.

II. Veit in 1902 promulgated an hypothesis along the lines of Ehrlich's side-chain doctrine, which for a time bid fair to solve the problem. Notwithstanding its failure to do so, his work has served to direct attention to the "biological" aspects of the question, and has been the incentive for a large amount of investigation.

This theory was based upon the fact that even in normal pregnancy varying amounts of *fœtal* ectoderm, and even fragments of chorionic villi, are constantly becoming separated from the placenta and gain access to the maternal circulation, the process being designated as "deportation." Veit contended that the *fœtal* elements give rise to a poison—syncytio-toxin, which is normally rendered innocuous by a supposititious antibody—syncytiolysin, which develops in the maternal serum. If, however, for any reason the former is present in quantities too great to be neutralized, or if the elaboration of the latter is interfered with, symptoms of poisoning result and eclampsia eventually follows.

He considered that the correctness of the theory was established, when he found that the injection of an emulsion of human placenta into the peritoneal cavity of rabbits was followed by albuminuria and sometimes by death. In drawing his conclusions, however, he overlooked the fact that similar results would follow the introduction of any heterogeneous animal tissue, and also that nature performs a much more ideal experiment whenever the rupture of a tubal pregnancy leads to the extrusion of the ovum into the peritoneal cavity. The fact that eclampsia does not supervene under such conditions speaks strongly against the correctness of this view. Ascoli, on the other hand, held that the disease was due to an excessive production of syncytiolysin.

These theories are at present regarded as untenable, more particularly as Frank and Heimann in 1911 were unable to demonstrate by means of the deviation of complement and other reactions that the maternal serum formed specific antibodies when human chorionic villi were employed as antigen.

III. Following Veit's theory, numerous investigators, including Liepmann, Weichhardt and Piltz, Freund, Guggisberg, and others, attempted to



prove that eclampsia is due to endotoxins contained in the chorionic villi, and more particularly in the syncytium.

They found that the intravenous injection into animals of emulsions or extracts of placenta were usually followed by rapid death and sometimes by convulsions. At autopsy widespread thrombosis was observed, together with variable lesions in the liver and kidneys. Freund accordingly concluded that the placenta contained a definite poison which was made up of at least two components—one giving rise to thrombosis, and the other acting on the nervous system.

Probably the most serious blow to this theory was struck by Lichtenstein in 1908, when he demonstrated that the results obtained were in great part mechanical, and could be produced equally well by the injection of indifferent materials, and furthermore that placental emulsions and extracts could be injected with impunity provided all suspended particles were removed by efficient filtration. Subsequent writers have failed to meet his criticism, nor do I believe that Guggisberg has refuted his conclusions.

Schmorl in his original monograph suggested that it was possible that the extensive thrombosis accompanying the disease might be due to the action of fibrin ferment. This view was practically abandoned until the chemical investigations of Hofbauer, Dryfuss, and others revealed the presence of amino acids and other substances in the placenta, which are in all probability due to the action of ferments. These authors accordingly suggested that a part of the lesion, at least, might be due to the escape of such ferments into the circulation.

Dienst in 1912 still further elaborated this view, and holds that eclampsia is due to an increase in the fibrogen and fibrin ferment content of the blood. He and Kollmann have demonstrated that both of these substances are nearly twice as abundant during pregnancy as at other times, and are still further increased in eclampsia. Dienst believes that normally coagulation of the blood is prevented by the elaboration of antithrombin in the liver, but, whenever, as the result of circulatory changes incident to pregnancy, that organ becomes insufficient, antithrombin is no longer excreted in sufficient quantity to neutralize the fibrin ferment, which consequently combines with the fibrinogen and inaugurates thrombosis. While this hypothesis is very clearly set forth, it is nevertheless probable that it will meet the same fate as its predecessors.

After Flexner had shown the part played by agglutination of the red corpuscles in the production of thrombosis, and Pearce had demonstrated the effect of hæmolysis upon the liver and kidneys, an attempt was made to isolate and explain the mode of production of such substances. Leith Murray believed that they are the essential factors in the production of the disease; while Freund and Mohr considered that they had solved the problem of hæmolysis by the isolation of oleic acid or sodium oleate in the placenta. It is generally believed, however, that the substances in question are merely constituents of the fat normally present in the placenta.

IV. The study of the metabolism of the mother during the eclamptic state and particularly the clinical examination of the urine have added



considerably to our knowledge, but have not yet given us a clue as to the ultimate cause of the disease.

Massen in 1895 found the relative amount of urea greatly diminished, and H  louin a few years later stated that the rapport azoturique—the relation of the amount of nitrogen contained in the urea to the total nitrogen—was profoundly altered. Normally the ratio varies between 80 and 90 per cent., but is greatly reduced in pre-eclamptic tox  mia and eclampsia. These findings were abundantly confirmed, and in several instances we have found that less than one half of the total nitrogen was excreted as urea. Furthermore, study of the “nitrogenous partition” by Whitney, Zweifel, Stone, Ewing and Wolf, and others, as well as in my service, shows a marked increase in the amino acids, as well as in the substances precipitated by phospho-tungstic acid, such as uric acid, creatinin, and the xanthin bases. The sum total of these substances, however, does not equal the entire amount of nitrogen contained in the precipitate, so that the deficit is designated as the “N rest.” This is greater in eclamptic than in normal urine, but whether it bears any relation to the production of eclampsia cannot as yet be stated. In any event, the study of the nitrogenous metabolism gives evidence of a profound derangement, and indicates imperfect oxidation and desamidation.

Recognizing these facts, Zweifel attempted to find some imperfectly oxidized body in the urine which might possibly give rise to eclampsia, and succeeded in demonstrating considerable quantities of sarcolactic acid, which was also found in the cerebro-spinal fluid by his pupils, F  th and Lockemann. Notwithstanding Zweifel’s careful work, it does not seem that we are justified in considering lactic acid as the cause of the disease, as it is probably only a result of the muscular work incident to the convulsions.

The intimate relation existing between the thyroid gland and metabolism led Nicholson to assume that eclampsia might be due to thyroid insufficiency, and to recommend the use of its extract in the treatment of the disease. Lange found that hypertrophy of the thyroid was one of the usual concomitants of normal pregnancy, and that its absence predisposed to the occurrence of a tox  mia. A considerable amount of work has been done in this direction, but has not yet led to definite results.

Vassale and Zangfrongini in 1905 ascribed a similar function to the parathyroid glands. It has, however, been indicated that insufficient secretion on their part leads to the production of tetany, and I think it permissible to agree with Seitz that they are not concerned in the   tiology of eclampsia.

V. Rosenau and Anderson in 1908 suggested that eclampsia might possibly represent an anaphylactic reaction. This idea was still further elaborated in 1910 and 1911 by Thies and Lockemann, and Gr  fenburg, who, after an extensive series of experiments, held that the mother was sensitized during pregnancy by small quantities of foetal protein and would go into anaphylactic shock if a quantity of foetal blood were suddenly introduced into her circulation. They identified the condition with eclampsia and claimed that the liver and kidneys presented characteristic lesions.



Notwithstanding the plausibility of these contributions, I feel that they have not solved the problem, more particularly as Johnstone and Felländer failed to verify them.

VI. As practically all other organs had been considered in connection with the ætiology of eclampsia, Sellheim suggested the possibility of its mammary origin. He based his supposition in great part upon the experience of veterinarians that the so-called paresis of cattle is relieved by the injection of air or of various medicaments into the breasts. In a patient in whom relief did not follow delivery, he felt justified in amputating both breasts, and, as she eventually recovered, he held that the mammary theory deserved further consideration.

It is interesting to note in this connection that Healy and Kastle of the Kentucky Agricultural Experiment Station, in 1912, consider that the so-called parturient paresis, or milk fever, of cows is identical with human eclampsia. This disease is characterized by coma, convulsions, albuminuria, a pronounced change in the nitrogen partition, and by the presence of casts. Its pathology is as yet unknown, but its mortality has been reduced from 60 to 0.5 per cent. by injecting the udders with oxygen. Furthermore, by the injection into guinea pigs of small quantities of colostrum, obtained from cows suffering from the disease, they were able to kill the animals and to find lesions highly suggestive of those characterizing eclampsia. Consequently, they suggest the possibility that eclampsia may be due to intoxication by poisons elaborated in the breasts, and thus add an experimental basis to Sellheim's apparently absurd suggestion.

In summing up the ætiology of eclampsia, it is evident that its cause is still undiscovered. All that we know positively is that the disease is accompanied by characteristic lesions in the liver and by striking changes in metabolism. Our clinical experience leads us to believe that it is dependent upon a profound toxæmia, which is probably metabolic in origin, but we are as yet ignorant whether the changes originate in the maternal or foetal organism or both.

**Diagnosis.**—The recognition of eclampsia usually offers no difficulty. It might be confounded with acute poisoning from strychnine, phosphorus, or nitrobenzol, as in a case reported by Schild. However, such instances are extremely rare, and careful inquiry into the history of the patient should prevent error. Generally speaking, one is much more likely to make the diagnosis of eclampsia too frequently than to overlook the disease, as uræmia, epilepsy, acute yellow atrophy of the liver, and even hysteria may simulate it. Consequently they should be borne in mind whenever convulsions or coma appear during pregnancy, labor, or the puerperium, and must be excluded before a positive diagnosis is made. Occasionally it is impossible to make an accurate clinical diagnosis, and in such cases only the finding of characteristic lesions at autopsy will enable one to be positive as to the nature of the affection.

 **Prognosis.**—The prognosis is always serious, eclampsia being one of the most dangerous conditions with which the obstetrician has to deal. The maternal mortality varies from 20 to 25 per cent., and that of the foetus from 33 to 50 per cent., although Stroganoff reports a maternal mortality

of 6.6 per cent. in a series of 400 cases. Such favorable results, however, are very exceptional.

The prognosis is generally considered to be more gloomy when the seizures come on before or during parturition than after delivery. Recent statistics, however, indicate that post-partum eclampsia is quite as serious, Olshausen and Lichtenstein having lost 25 and 27 per cent. of their cases, respectively.

There is considerable discrepancy of opinion concerning the relative prognosis in primiparous and multiparous women. Thus, Veit in 902 cases gives a corrected mortality of 14.3 per cent. for the former and 19.1 per cent. for the latter, and Goldberg and Lichtenstein state the disorder is twice as dangerous in the latter. Olshausen, on the other hand, believes that there is no difference in the two groups. In all probability the prognosis really depends much more upon the severity of the attack than upon the number of children that the woman has borne.

In individual cases it is often extremely difficult to predict the course of the disease, some patients dying in the first seizure, while others recover after more than 30, Jardine reporting a recovery after 200 convulsions. Seitz states that the prognosis becomes worse with each convulsion up to 20 or 30, but that a greater number does not necessarily add to the gravity of the case, the prognosis depending upon the rapidity with which they follow one another and the duration of the coma after each attack.

Valuable prognostic data are also afforded by the condition of the pulse and temperature. When the former is of fair quality between the attacks the outlook is usually good; whereas a weak, rapid, and thready pulse usually indicates a fatal issue, particularly if the temperature is high. The persistence of a high arterial pressure is always of bad prognostic significance, even when the other symptoms seem to improve. Complete anuria and the inability to sweat in a hot pack are ominous symptoms. Apoplexy, paralysis, and œdema of the lungs are most serious complications and usually end in death.

If the eclampsia comes on during pregnancy the prognosis is very favorably affected by the death of the fœtus, the convulsions usually ceasing soon afterward.

If the patient recovers, it is unusual for eclampsia to occur in subsequent pregnancies, as one attack apparently confers a relative immunity. On the other hand, in patients suffering from chronic nephritis the recurrence of uræmic convulsions is not uncommon.

**Treatment.**—(a) *Prophylactic.*—The prophylactic treatment is most important, and is identical with that recommended for pre-eclamptic toxæmia (p. 532). Indeed, the chief aim in treating the latter condition is to prevent the possible outbreak of eclampsia. Hence the necessity of regular and frequent examinations of the urine, and the immediate institution of appropriate treatment and diet as soon as symptoms appear, which indicate that the eliminative processes are at fault. By the employment of these precautionary measures, and by promptly inducing premature labor in those cases which do not improve, or which become progressively worse under treatment, the frequency of eclampsia will be greatly dimin-



ished and many valuable lives saved. At present, however, despite all we can do, eclampsia will still occur, and sometimes even in patients who apparently have responded most satisfactorily to prophylactic treatment. Thus, I could cite several instances in which, under appropriate measures, the subjective symptoms disappeared, the urine and its nitrogenous content increased in quantity and the albumin decreased, and yet, just as I was congratulating myself upon a most satisfactory result, a convulsion occurred. Moreover the outbreak of eclampsia is not always preceded by premonitory symptoms, as several of my patients who were apparently perfectly well, and whose urine had shown no abnormality the day before, had a seizure during labor.

Such experiences have convinced me that prophylactic treatment, while productive of untold good, is not invariably successful or always applicable, nor can I agree with Davis and Edgar that eclampsia is always a preventable affection.

Experience goes to show that cases of pre-eclamptic toxæmia accompanied by œdema are more amenable to treatment, and less likely to eventuate in eclampsia, than those in which it is absent. This point was emphasized many years ago by Stolz.

(b) *Curative.*—When convulsions occur during pregnancy or labor, I believe that the best results are obtained if delivery is effected as soon after the first convulsion as is consistent with the safety of the patient. Unfortunately, perfectly definite rules cannot be laid down, as the treatment should vary materially according as the patient is in a hospital or in her own home, and is under the care of a competent obstetrician or of an average general practitioner.

If the obstetrician is prepared to meet any emergency, delivery should be promptly effected irrespective of the condition of the cervix, or whether labor has begun or not. The patient should be anæsthetized with ether, placed upon the operating table, and carefully examined for the purpose of determining the most conservative method of procedure. If the cervix is fully dilated, the child should be delivered by means of forceps or version and extraction, as may seem best. If, however, this is not the case, the choice of operation will depend upon the condition of the cervix. If it is partially dilated, or if its canal is obliterated and resistance is offered only by the external os, dilatation can usually be safely and rapidly completed by Harris's manual method. On the other hand, if labor has not begun and the cervix is hard and its canal not obliterated, neither manual nor instrumental dilatation should be attempted, but vaginal hysterotomy should be performed, and the child delivered after version and extraction.

In the treatment of such cases, I prefer vaginal hysterotomy, instead of abdominal Cæsarean section as recommended by Halbertsma, for the reason that the former is less dangerous, and is followed by a more rapid convalescence. I believe that the latter is indicated only when the eclampsia is complicated by contracted pelvis, tumor formations, or some other condition which would necessitate its performance irrespective of its existence.

If the medical attendant is not a competent operator, or is unable to



secure the services of one, treatment should be far less radical. If the patient is in labor, delivery should be completed by forceps or version if the condition of the cervix will permit; while if it be partially dilated, the process may be completed by Harris's manual method. On the other hand, if labor has not set in, no attempt should be made to dilate the rigid cervix, and, as vaginal hysterotomy is out of the question, the physician should be content with purely medical treatment, as will be outlined below. I give this advice, as I know from my own experience that forcible attempts at accouchement forcé will expose the patient to risks of laceration, hæmorrhage, or infection quite as great as those of the underlying disease, and it is far better, if she is to die, that she succumb to the eclampsia rather than to misdirected efforts on the part of the physician.

The question as to the advisability of early operative interference, in my opinion, can only be decided by determining the proportion of cases in which the convulsions cease after the birth of the child. Statistics bearing upon this point have been adduced by Dührssen, Olshausen, and Zweifel, who noted a cessation of the seizures either immediately or soon after delivery in 93.75 per cent., 85 per cent., and 66 per cent. of their cases respectively. Zweifel and Seitz report a mortality of 28.5 and 11.25, and of 28.6 and 6.5 per cent. under expectant and active treatment, respectively. Judging from these figures, it would appear that prompt delivery is indicated whenever it can be accomplished in a conservative manner. On the other hand, Lichtenstein contends that the benefits of early operation are in great part illusory, and depend almost entirely upon the extra amount of blood lost during the operative procedure, and he holds that equally good results would follow venesection and the spontaneous termination of labor. In his 400 cases the total mortality was 18.5 per cent. Included in the entire series were 70 post-partum cases with a mortality of 27 per cent., and he plausibly inquires why this should be the case if early delivery so favorably affects the prognosis; as in this group of cases delivery was effected some time before the outbreak of the first convulsion. He believes that the answer is to be found in the fact that most of these women were delivered spontaneously and consequently had lost only a minimum amount of blood.

For years Veit, Charpentier, de la Harpe, and others have advocated the administration of large doses of morphia, and do not interfere until the cervix is completely dilated. Stroganoff has gone a step further, and between the years 1897 and 1910 has treated 400 cases of eclampsia with a net mortality of 6.6 per cent. He administers a large dose of morphia and chloral immediately after the first convulsion, repeating the dose sufficiently often to keep the patient narcotized, and interferes only after the cervix has become completely dilated. Roth in 1910 reported a similar experience in a small series of cases from Leopold's clinic, but with this exception no one seems to have taken Stroganoff's suggestion seriously.

Notwithstanding the claims of Lichtenstein and Stroganoff, I am still a firm believer in early delivery, and do not expect to give it up until the claims of its opponents appear more convincing. Following the delivery



of the child, no attempt should be made to hasten the third stage of labor, as a moderate loss of blood should be encouraged rather than checked.

After the completion of labor, or in the cases in private practice in which rapid delivery appears to be contra-indicated, as well as in post-partum eclampsia, the various organs of elimination should be stimulated as energetically as possible. If the bowels have not moved, 1 drop of croton oil in a half dram of olive oil should be administered by mouth, or 2 ounces of Epsom salts should be given through a stomach tube. Sweating should be encouraged by hot packs, or at least by covering the patient with a rubber sheet and surrounding her with bottles filled with hot water, but taking every precaution to prevent her from being burned. Pilocarpin should not be used on account of its tendency to produce œdema of the lungs.

Diuresis should be promoted by the subcutaneous injection of salt solution, as well as by copious high rectal enemata. In view of the supposedly acid nature of the eclamptic poison, Zweifel advocates replacing the salt solution by one containing 5 grams each of sodium chloride and sodium bicarbonate to the liter. Macé and Pierra, in consequence of their observations upon the freezing point and chloride content of the blood and urine, object to the use of salt solution in the treatment of eclampsia. Their teachings, however, do not accord with my clinical experience.

If the patient does not soon show marked signs of improvement, from 500 to 600 cubic centimeters of blood should be withdrawn. If beneficial results follow, the procedure may be repeated if necessary. As the average woman possesses from  $8\frac{1}{2}$  to 9 pounds of blood, 500 cubic centimeters would represent from  $\frac{1}{8}$  to  $\frac{1}{9}$  of its total bulk. Accordingly, if that amount of blood is drawn off and replaced by an infusion of an equal quantity of salt solution, the remainder of the blood is so diluted that  $\frac{1}{4}$  or  $\frac{1}{5}$  of the total poison has been temporarily removed, and this aid is often sufficient to tide the patient over sufficiently long to allow Nature to reassert herself.

It is generally stated that bleeding is indicated only when the pulse is full and bounding. Personally, I have bled with most excellent results a number of patients whose pulse was thin and weak. This experience would certainly seem to show that venesection is indicated in all cases in which delivery of the child is not followed by a cessation of the convulsions, no matter what the condition of the pulse, and it should form our main reliance in cases of post-partum eclampsia.

If the convulsions persist, inhalations of ether may be given during the seizures, in the hope of cutting them short, although I believe that they are useless. Chloroform was formerly freely used, but, in view of its well known deleterious action upon the liver, I advise against its employment. During the attack a thick cord or folded towel should be placed between the teeth in order to prevent the patient from biting her tongue. No food, and as little medicine as possible, should be administered by mouth as long as the patient is unconscious, since particles may find their way into the air passages, instead of being swallowed, and later give rise to an inspiration pneumonia. As soon as the patient regains consciousness, fluids

should be forced, and she should be encouraged to drink 4 or 5 liters of water or milk for each of the first few days of the puerperium.

Thyroid extract has been advocated in the treatment of eclampsia by Nicholson, who advises that 70 to 80 grains be given daily during the attacks. It was used by Strumer in a series of 41 cases with 5 deaths, and by Lobenstein in 6 cases with 1 death. Since other therapeutic measures were employed as well, it is impossible to judge of its efficiency. In the few instances where it was used in my clinic favorable results were not obtained. In 1904 Krönig employed lumbar puncture in 3 cases of eclampsia with apparent beneficial results. He found the cerebro-spinal fluid under increased tension, and noted a pressure of 400 to 500 millimeters of mercury compared with the normal of 120 millimeters. Henkel, Thies, Pollack, and others who have employed the procedure are very sceptical as to its value.

Renal decapsulation was performed in a case of eclampsia by Edebohls in 1902, although it had previously been suggested by Sippel. Edebohls considers that it acts favorably by relieving the intrarenal tension, and thereby favors the resumption of urinary secretion. The subject has been reviewed by Chamberlent and Pousson, Pinard, and Sippel, who believe that it is of value in cases of total suppression following delivery, and may be employed as a last resort.

The use of *veratrum viride*, which is highly praised by so many American writers, has never appealed to me upon theoretical grounds, and Sturmer's statistics from the East India Medical Service, where it was used for twenty years, show a maternal mortality of 45 per cent. After reading the enthusiastic report of Mangiagalli and of Cragin and Hull concerning its merits, I felt that I was perhaps not doing my duty to my patients by rejecting it. Accordingly, in a series of cases I gave it to every other patient, while the alternate patient was treated in identically the same manner except for the *veratrum*. While the hypodermic administration of 5 to 10 minims of the fluid extract, repeated if necessary, undoubtedly led to a marked slowing of the pulse, and occasionally to an almost alarming fall in blood pressure, the patients did neither better nor worse than those who did not receive it. For this reason I have abandoned its use.

Engelmann in 1911 reported good results in 14 cases of eclampsia by the intravenous injection of 0.2 to 0.3 gram of hirudin (leech extract) in a liter of Ringer's solution. The remedy is employed with the idea that it will inhibit coagulation of the blood and thus prevent thrombosis. Engelmann recommends its employment particularly in severe cases of post-partum eclampsia, but admits that further experience will be necessary before its merits can be fully determined.

In view of the marked liability of eclamptic women to infection, all operative procedures must be conducted in the most rigidly aseptic manner, particular care being taken to avoid the contamination of the vagina and the hands of the operator by fecal material.



## PRESUMABLE TOXÆMIAS

Under this heading are included a number of conditions occurring during pregnancy and the puerperium, concerning whose nature and origin we are as yet ignorant, but which are most readily explained by supposing that they are dependent upon some variety of auto-intoxication.

Certain psychoses clearly belong in this category. In some cases they are definitely associated with pre-eclamptic toxæmia, and disappear as the underlying condition becomes ameliorated.

I recall one patient who, during the later months of pregnancy, suffered from delusions of persecution. At such times large amounts of albumin were present in the urine, while the urea output was greatly diminished. Sweat baths were repeatedly followed by an immediate improvement in the condition of the urine, after which the mental condition became normal, the delusions reappearing, however, within a few days, to again disappear under the same treatment. Complete recovery followed delivery.

Again, some cases occur in which the most careful study of the urine fails to reveal the slightest evidence of toxæmia, and yet the mental derangement promptly disappears upon the employment of milk diet, rest, and eliminative treatment. On the other hand, most of the psychoses occurring during the puerperium are to be regarded as manifestations of infection, and are directly due to the absorption of poisonous materials generated by infectious micro-organisms.

Many cases of peripheral neuritis should also be regarded as due to toxæmia, and we have already referred to its frequent association with the vomiting of pregnancy. Lindemann, in a fatal case, clearly showed that the nerve lesions were associated with degenerative changes in both the liver and kidneys. On the other hand, as far as can be ascertained by clinical observation, such an association is absent in other cases, but even here it is permissible to believe that the underlying factor must be an auto-intoxication of some character.

Likewise certain non-contagious skin diseases, such as impetigo and herpes gestationis, are susceptible of a similar explanation, and sometimes yield to a milk diet and proper eliminative measures after obstinately resisting the usual local and medicinal treatment. Excessive salivation, which sometimes occurs in pregnant women, is also probably due to a toxæmia of some kind, as is particularly shown in the cases associated with vomiting of pregnancy. At the same time, intense salivation may occur without such an association, and resists all remedial measures until the patient is placed in bed and put upon a rigorous milk diet.

Dirmoser, Sondern, and others have insisted that auto-intoxication from the intestinal tract plays a prominent part in the production of many of the abnormalities of pregnancy; and the former holds that most cases of vomiting of pregnancy are due to such a condition, and considers that the presence of indican, indol, skatol, and ethereal sulphates in the urine affords strong evidence in favor of such a view. Glaessner has shown that profound symptoms of auto-intoxication can be produced experimentally in

dogs by reversing the direction of intestinal peristalsis. In such cases marked changes are manifested in the urine, which consist particularly in a distortion of the relative proportions of its nitrogenous constituents.

Occasionally women suffer from asthma in every pregnancy, but at no other time; and there is a certain amount of evidence available which points to its being due to an underlying toxæmia. Thus, I have seen several patients in whom the condition was not relieved by medicinal treatment, yet yielded readily to milk diet and eliminative measures; though at no time could changes be demonstrated in the urine in support of its toxæmic origin. On the other hand, in one of my cases the condition was associated with pre-eclamptic toxæmia, and disappeared only after the induction of premature labor.

Occasionally conditions occur during the puerperium which can only be explained upon the assumption of an underlying toxæmia. Thus, I have seen three women, whose urine was apparently perfectly normal, go through an uneventful pregnancy and labor, and on the second or third day of the puerperium pass into a comatose condition, which persisted for several days, but from which they slowly recovered. In each instance a careful chemical and microscopical examination of the urine was made, but failed to reveal any abnormality. In one of these patients there was slight jaundice, and the clinical symptoms were such that one was forced to consider the possibility of acute yellow atrophy of the liver. As all of the patients recovered, it is naturally impossible to speak positively as to the nature of the condition, but, notwithstanding the negative results obtained by the study of the urine, it is difficult to explain its production by any other supposition than that of a profound toxæmia. This being the case, it must be admitted that we occasionally have to deal with conditions which in all probability are toxæmic in origin, but concerning whose nature we are as yet absolutely ignorant.

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## CHAPTER XXVII

### COMPLICATIONS DUE TO DISEASES AND ABNORMALITIES OF THE GENERATIVE TRACT

#### DISEASES OF THE VULVA AND VAGINA

**Varices.**—Varicose veins sometimes appear in the lower part of the vagina, but are more common around the vulva, where they may attain considerable proportions and give rise to a sensation of weight and discomfort. Treatment has practically no effect upon the local condition. In rare instances the varices may rupture during pregnancy, though this accident is more frequently observed at the time of labor, when profuse and sometimes fatal hæmorrhage may result if appropriate surgical treatment is not available.

**Inflammation of Bartholin's Glands.**—Pyogenic micro-organisms may gain access to Bartholin's glands and give rise to abscess formation. In such cases the labium majus on the side affected becomes swollen and painful, and incloses a large collection of pus. Most often the infection is gonorrhœal in origin, though other bacteria are sometimes associated with the gonococcus. Aside from the pain and discomfort, this complication is a possible source of danger during labor and the puerperium, since it may be the starting-point of a puerperal infection. For these reasons, whenever a labial abscess develops during pregnancy it should be opened up and drained; or, better still, the entire pus sac should be excised.

**Relaxation of the Vaginal Outlet.**—In multiparous women the congestion incident to pregnancy not uncommonly causes the anterior or posterior vaginal wall to protrude through the relaxed or torn outlet as a distinct cystocele or rectocele. This condition is generally associated with dragging pains in the back and lower abdomen, and often interferes with locomotion. It is not amenable to treatment during pregnancy, though the symptoms may be temporarily relieved by rest in bed.

**Vaginitis.**—This complication has already been considered in Chapter XXV, under the heading of Gonorrhœa.

**Colpo-hyperplasia Cystica.**—This rare condition, first described by Winckel, is characterized by the presence in the vaginal mucosa of numerous small cavities filled with clear fluid or gas and forming elevations upon its surface. Although not amenable to treatment during pregnancy, it usually disappears soon after childbirth. The researches of Lindenthal render it probable that the disease, in many cases at least, is due to infection with *Bacillus aerogenes capsulatus*, and Jaeger has been able to produce it experimentally in animals.



## DISEASES OF THE CERVIX

**Cervical Endometritis.**—Gonorrhœal infection of the cervical canal is frequently observed during pregnancy, the most prominent symptom being a profuse and persistent leucorrhœa. The treatment has already been considered.

**Carcinoma.**—About once in 2,000 cases, according to Sarwey, pregnancy is complicated by carcinoma of the cervix. It is most common in women between the thirtieth and fortieth years of life, two thirds of the cases collected by Sarwey having occurred within this decade, while the youngest patient was twenty-six years old.

In the majority of instances the condition has existed before conception, but it may make its appearance during pregnancy. A bloody, foul-smelling vaginal discharge is suggestive of malignant disease, but unfortunately the early stages are often unaccompanied by symptoms, and may escape detection unless a vaginal examination is made for some other reason, and an indurated and excavated ulceration of the cervix is discovered.

Pregnancy tends to bring about rapid growth and extension of a pre-existing carcinoma. On the other hand, the malignant disease influences pregnancy very unfavorably, abortion being noted in 30 to 40 per cent. of the cases. It likewise predisposes to the occurrence of placenta prævia, and at the time of labor markedly increases the risks of infection or of spontaneous rupture of the uterus. In advanced cases the cervix may be so indurated by carcinomatous infiltration that dilatation is either impossible, or may be accompanied by profuse hæmorrhage. In 603 cases collected by Sarwey the mortality at the time of labor, or during the puerperium, was 43.3 per cent., 8 per cent. of the patients dying undelivered.

The treatment of pregnancy complicated by carcinoma of the cervix differs according to the period at which the diagnosis is made and the extent to which the disease has progressed. If the condition is detected in the first half of pregnancy and has not extended beyond the cervix, immediate hysterectomy should be performed without regard for the chances of the foetus. Sarwey has reported 26 vaginal operations without a death; but I consider that a radical abdominal operation will materially increase the probability of a permanent cure. On the other hand, if the case is inoperable, gestation should be allowed to continue in the interests of the child.

In the second half of pregnancy the large size of the uterus materially complicates vaginal hysterectomy. Hence, if a radical operation appears advisable, laparotomy should be performed and the uterus removed unopened. In inoperable cases pregnancy should be allowed to go on to term, and then, if spontaneous delivery is out of the question, Cæsarean section should be performed in the interests of the child. For particulars concerning operative treatment the reader is referred to the articles of Sarwey and Noble, the latter having collected the results obtained in 166 cases observed between the years 1886 and 1896.

## DEVELOPMENTAL ABNORMALITIES OF THE UTERUS

Abnormalities in the development or fusion of one or both Müllerian ducts may result in malformations, which sometimes possess an obstetrical significance. Various degrees of malformation—from an almost total absence of the uterus on the one hand to its duplication on the other (uterus didelphys)—are encountered. The accompanying diagrams (Figs. 458 to 463) give an idea of the nature of the more important varieties.

Pregnancy may be associated with any one of these malformations, provided an ovum be cast off from the ovaries and no serious obstacle be opposed to the upward passage of the spermatozoa and their subsequent union with it.

**Pregnancy in the Rudimentary Horn of a Double Uterus.**—In this condition the course of pregnancy is exposed to serious modifications. We owe to Mauriceau the first description of a case



FIG. 458.—DIAGRAM OF UTERUS UNICORNIS (Kehrer).



FIG. 459.—UTERUS PSEUDO-DIDELPHYS (Kehrer).



FIG. 460.—UTERUS BICORNIS DUPLEX (Kehrer).



FIG. 461.—UTERUS BICORNIS SEPTUS (Kehrer).



FIG. 462.—UTERUS BICORNIS SUBSEPTUS (Kehrer).



UTERUS BICORNIS UNICOLLIS (Kehrer).

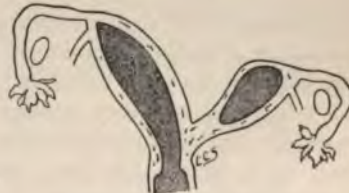


FIG. 463.

UTERUS BICORNIS UNICOLLIS WITH RUDIMENTARY HORN (Kehrer).



of this character, but since his time quite a number of examples have been reported.

In 78 per cent. of the 84 cases collected from the literature by Kehrer, in 1900, the proximal end of the rudimentary horn did not communicate with the uterine cavity, so that in them pregnancy must have followed external migration of the spermatozoa or the ovum.

The occurrence of pregnancy in a rudimentary horn is dependent upon the development of normal decidual and placental tissue, and is also



FIG. 464.—PREGNANCY IN A RUDIMENTARY LEFT UTERINE HORN EXTERNAL MIGRATION OF OVUM (Kelly).

The specimen is viewed from behind. To the right is the well-developed uterus, which, after reaching the internal os, deviates to the right side. Attached to the cornu is the right tube, which is normal. The ovary is of the usual size, and at its inner and lower portion is the corpus luteum of pregnancy. Springing from the left side of the uterus at the internal os is a muscular band; on tracing this to the left it merges into the rudimentary uterine horn. On the posterior surface of this horn is a long slit representing the point of rupture. Protruding through the rent are placental remains. The left tube passes off from the outer side of the rudimentary horn. The left ovary is flattened. The lines on the well-developed uterus indicate the size of the uterine cavity. The line *b, c, d, e* indicates the course of the left Müller's duct. Between *c* and *d* it contains a lumen; where it is represented by dotted lines it consists of a solid muscular cord.

accompanied by the formation of a decidua in the non-pregnant horn, as well as by a marked increase in its size. Unless there is free communication between the two horns, which is but rarely the case, a pregnancy in this situation is a very serious occurrence, since normal delivery is impossible. If the muscular tissue of the rudimentary horn is poorly developed, as is usually the case, spontaneous rupture occurs within the first four months and may lead to the death of the patient from intra-peritoneal hæmorrhage. This accident was noted in 87, 47.6, and 5.5 per cent. of the cases collected by Sängner, Kehrer, and Beckmann, respectively, in

1884, 1900, and 1911. The marked difference in the percentages is attributable to greater accuracy in diagnosis and more frequent recourse to operative interference. On the other hand, if the muscular tissue is abundant the pregnant horn may hypertrophy normally, and the pregnancy go on to term. If not removed by operative means, the foetus may be gradually eliminated by suppurative processes, or be converted into a lithopædion.

The existence of pregnancy in a rudimentary horn can occasionally be recognized during the early months, a positive diagnosis having been made in 20 per cent. of Kehrer's cases. When a tumor corresponding in size to the duration of pregnancy can be detected alongside of what appears to be the slightly enlarged uterus, this condition should always be thought of. In differentiating it from a tubal pregnancy, it is important to remember that the round ligament is felt coming off from the distal side of the tumor instead of from its proximal or uterine portion, as in the latter condition. In the later months, a diagnosis is usually not made until false labor sets in at term. In other cases this does not occur and the child dies; but, in either event, no abnormality is suspected until one attempts to empty the uterus, when it is found that its cavity is empty and that the child lies in a sac to one side of it, which must represent either a pregnant tube or a rudimentary horn. A satisfactory differentiation can always be made by determining the location of the round ligament as described above.

*Treatment.*—If the condition be diagnosed, treatment consists in promptly opening the abdomen and amputating the pregnant horn. This operation was first performed by Säger in 1884, and has since been repeated on many occasions with constantly improving results, Kehrer and Wells having reported 44 cases up to 1900, and Beckmann a large series in 1911, with a mortality of 13.3 and 4.3 per cent., respectively. Too frequently, however, the first suggestion of the existence of the abnormality is afforded by the symptoms of intra-peritoneal hæmorrhage, and an operation is usually undertaken in the expectation of finding a ruptured extra-uterine pregnancy.

**Pregnancy in Uterus Unicornis.**—Occasionally only one horn of the uterus is developed, the opposite tube and ovary being lacking or arising from the lower portion of the uterus. In such cases pregnancy usually pursues an uneventful course, and the condition is only accidentally recognized at the autopsy table.

**Pregnancy in Uterus Bicornis.**—When the two horns of the uterus are well developed, but no connection exists between them, as in uterus didelphys, or when they are partly fused, as in the various varieties of uterus bicornis, pregnancy may occur in either horn. In the very rare instances in which a twin pregnancy is observed, the two ova may occupy the same horn, although now and again an ovum has been found in each.

When pregnancy occurs in one horn of a bicornuate uterus, the other undergoes sympathetic hypertrophy and a distinct decidua is formed in its cavity. Ordinarily there is no interference with the course of pregnancy, and spontaneous labor may be looked for. Much more rarely the non-pregnant horn may partially fill up the pelvic cavity, and give rise to serious



dystocia similar to that produced by tumors of other origin. Nagel mentions three cases in which labor could not proceed until this structure had been pushed out of the pelvic canal. In two other instances—one reported by Löhlein and one observed in my clinic and reported by Bettman—the non-pregnant horn obstructed the pelvic cavity and gave rise to rupture of the uterus. Werth has reported a case in which the non-pregnant horn became retroflexed.

The diagnosis is usually not made, as in the majority of cases spontaneous labor occurs at term; although Halban states that a pathognomonic sign is afforded by the palpation of the vesico-rectal ligament, as a band extending upward from the bladder over the top of the uterus, and lying between the two round ligaments. Our own patient had given birth to 8 children without any suspicion of the existence of the deformity having arisen. Sometimes the existence of a double vagina or a double cervix puts one on the alert. The former may occur with a normal uterus, whereas the latter condition almost invariably indicates the existence of a double, or at least a bicornuate, uterus. When there is only a single cervix, as in uterus bicornis unicollis, the condition always escapes observation, unless the patient is subjected to examination at an early period of pregnancy, and the depression noted between the two halves of the uterus gives a clue to the true state of affairs.

#### DIVERTICULA FROM UTERINE CAVITY

Freund and Schickele have reported instances in which the pregnancy developed in a diverticulum from the uterine cavity, so that the fœtus lay in a sac surrounded by uterine muscle, and connected with the main uterine cavity only by a narrow passage. It is apparent that it would be extremely difficult to recognize such a condition, unless the fingers were introduced into the uterine cavity, and that it may give rise to serious complications at the term of labor.

#### DISPLACEMENTS OF THE UTERUS

**Anteflexion.**—Slight degrees of anteflexion are frequently observed in the early months of pregnancy, but are usually without significance. In the later months, particularly when the pelvis is markedly contracted or the abdominal walls are very lax, the uterus may fall forward, the sagging being occasionally so marked that the fundus lies considerably below the lower margin of the symphysis pubis. Even in less marked instances of the so-called *pendulous abdomen*, the patient may complain of various annoyances, more especially of exhaustion on exertion and dragging pains in the back and lower abdomen. Marked amelioration frequently follows the wearing of a properly fitting abdominal supporter.

**Anteversio** of the pregnant uterus is occasionally observed in patients who have previously been subjected to operative procedures for the relief of symptoms incident to retroflexion of the uterus, particularly after vaginal fixation, less frequently after an improperly performed ventro-

suspension, and now and again after shortening of the round ligaments. The condition is accompanied by marked discomfort during pregnancy, and at the time of labor may give rise to serious dystocia, which will be considered in Chapter XXXII.

**Retrodisplacement of the Pregnant Uterus.**—Retroflexion and retroversion of the uterus are frequently observed in non-pregnant women, and usually cause more or less inconvenience, though occasionally the condition may exist for years without any abnormal manifestation. In women who have never borne children inflammatory or other changes in the endometrium, resulting from circulatory disturbances incident to the displacement, offer a serious obstacle to the occurrence of pregnancy. In parous women, on the other hand, this influence is less pronounced, but pregnancy, when it occurs, is prone to early interruption. The abortion is usually due to inflammatory or trophic changes in the endometrium, which are in great part dependent upon abnormalities in the circulation of the displaced uterus.

In the vast majority of cases of pregnancy complicated by retrodisplacements the uterus was already out of place before conception; although, as has been pointed out by Keitler and others, the abnormality may arise during gestation.

Pregnancy is more frequently complicated by retroflexion than by retroversion, though the latter may give rise to more serious symptoms. In either case several eventualities are possible: the displacement may undergo spontaneous reduction without any interruption to pregnancy; abortion may occur; or, if neither takes place, the uterus may become incarcerated in the pelvic cavity and serious consequences follow.

If the displaced uterus is not adherent, spontaneous reduction usually occurs during the second or third month. This is rendered possible by an eccentric hypertrophy of the organ, owing to which the anterior wall becomes more rapidly distended than the posterior, and emerging above the superior strait eventually draws up the rest of the uterus. After the fundus has once passed the promontory of the sacrum there is no fear of



FIG. 465.—SACCUATION OF RETROFLEXED PREGNANT UTERUS (Oldham).



a recurrence of the condition. Moreover, spontaneous reduction is not wholly out of the question, even when adhesions exist, since they often become stretched and occasionally disappear without any treatment. Retroflexion offers better prospects than retroversion; indeed, as Dührssen and Keitler have pointed out, when the latter condition is marked spontaneous restitution is almost impossible, for the reason that the cervix rises above the symphysis pubis, while the fundus is held back by the promontory of the sacrum.

In a certain number of cases, especially when the fundus is firmly adherent, pregnancy may remain uninterrupted for a long while. This prolongation is rendered possible by the marked upward growth of the anterior wall of the uterus, while the posterior wall retains its original situation and forms a cavity in which one pole of the fœtus is retained.



FIG. 466.—INCARCERATION OF RETROFLEXED PREGNANT UTERUS (Swytzer).

This so-called *sacculation of the uterus* has been described in detail by Oldham, Dührssen, and others. Owing to the abnormal position of the cervix and the fact that the presenting part lies far below it, serious difficulties are to be expected at the time of labor, which will be considered in Chapter XXXII.

Abortion is common in pregnancies complicated by retrodisplacements. It usually occurs in the course of the third month, when the growing uterus pretty well fills the pelvic cavity and, becoming irritated by the pressure to which it is subjected, begins to contract, and thus brings about the expulsion of the ovum. This termination is particularly likely to occur when the sacrum possesses a marked vertical concavity, since the projecting promontory opposes a serious obstacle to spontaneous restitution.

If pregnancy continues and the displacement is not reduced in the natural course of events, or as the result of manipulations on the part of the physician, the uterus will continue to increase in size until it com-

pletely fills the pelvic cavity and, being unable to free itself, becomes impacted, and we have what is known as *incarceration*. Untoward effects, due to pressure, come on sooner in retroversion than in retroflexion, for the reason that in the former the cervix compresses the lower portion of the bladder at an earlier period. Incarceration is accompanied by characteristic symptoms, the woman complaining of pain in the lower portion of the abdomen and back, and disturbances in the functions of the urethra, bladder, and rectum. As the pelvis becomes more and more filled by the growing uterus, the pressure upon the neck of the bladder and urethra becomes so intense as to cause retention of the urine with consequent overdistention. Reed, however, holds that the ischuria should not be attributed to mere mechanical pressure upon the urethra, but is due to compression of the pelvic ganglia by the body of the uterus, with resulting paralysis of the motor nerves of the bladder. But, whatever its cause, when the retention has reached a certain limit, the overstretched viscus squeezes out a small amount of urine at frequent intervals, but never empties itself—*paradoxical incontinence*. If the condition is not soon relieved, the symptoms become more intense, cystitis develops, and the bladder walls become thick and oedematous, the urine becomes bloody, and eventually gangrene of the bladder may result, necrotic portions of its lining membrane being cast off and finally expelled through the urethra with intense cramp-like pains. In other cases the weakened walls of the bladder are unable to withstand the distention and rupture occurs, followed by a fatal peritonitis.

Occasionally the uterus may undergo inflammatory changes as the result of the pressure to which it is subjected, and become densely adherent to the surrounding parts, while now and again the organ may be forced down and out of the pelvic cavity and emerge through the vulva or anus. In some cases the rectum is compressed to such an extent that defecation becomes impossible and gangrene results. Ileus, however, is an exceedingly rare complication.

Gottschalk found that the following were the most frequent causes of death in 67 cases reported in the literature up to 1894:

|                                    |    |
|------------------------------------|----|
| Peritonitis of vesical origin..... | 17 |
| Uræmia .....                       | 16 |
| Rupture of the bladder.....        | 11 |
| Septicæmia of vesical origin.....  | 4  |
| Gangrene of the bladder.....       | 3  |

A retrodisplacement of the pregnant uterus should always be suspected when a woman in the early months of pregnancy complains for any length of time of frequent and painful micturition, especially if there is a history of antecedent uterine trouble. Incontinence of urine during pregnancy is a most suggestive sign, and always calls for a thorough vaginal examination. With the bimanual method, the soft body of the uterus will be found occupying the pelvic cavity, while the cervix is forced up against the symphysis or lies above it, according as one has to deal with a retroflexion or retroversion. It should be remembered that a pregnant tube lying behind the uterus may give somewhat similar signs, and this possibility should



not be ruled out until careful examination has shown that the slightly enlarged uterus does not lie in front of the soft mass.

*Treatment.*—If the condition be detected in the first three months of pregnancy, bimanual reposition of the uterus should be attempted, aided by traction upon the cervix by means of a tenaculum or bullet forceps. After reposition has been effected, a properly fitting Smith-Hodge pessary should be introduced. On the other hand, if these simple manœuvres fail, the patient should be left alone until well on into the third month, in the hope that spontaneous reduction may still occur. If this has not taken place by that time, a more determined effort at replacement should be made, with the patient in the knee-chest position. If this proves unsuccessful, reduction can usually be effected by bimanual manipulations under anæsthesia.

When dense adhesions are present, various procedures have been recommended—the forcible attempt to break them up under anæsthesia, attempts to loosen them by means of a succession of vaginal packs, the colpeurynter, or the “watch-spring” pessary, from the use of which Sinclair has reported excellent results.

Generally speaking, these methods are not to be recommended, and, if the uterus cannot be replaced under anæsthesia, laparotomy should be performed and the adhesions separated under the guidance of the eye, as recommended by Mann and Fry. In several of my cases this course was pursued with most satisfactory results.

On the other hand, if symptoms of incarceration supervene, prompt treatment is imperative. The bladder should be immediately emptied. This cannot always be accomplished with the ordinary female catheter on account of the elongation of the urethra and neck of the bladder resulting from the displacement (Fig. 466), so that in many cases a long, flexible instrument must be employed. Its introduction may often be facilitated by making traction upon the cervix with a tenaculum. After the bladder has been emptied, attempts should be made to replace the uterus—under anæsthesia, if necessary. But if this cannot be effected, most authors advise emptying it immediately, either by dilating the cervical canal or by puncturing the corpus through the vaginal vault. I believe that better results will be obtained in such cases by laparotomy, as recorded by Lobenstine. This operation, however, should never be attempted if symptoms of infection or gangrene are present, since the weakened and necrotic bladder may be injured, or dense adhesions may be encountered which have formed over the uterus, practically shutting it off from the abdominal cavity and rendering the freeing of it almost impossible. Under these circumstances the obstetrician should content himself with emptying the uterus in the most conservative manner, which sometimes is best effected by incising its posterior wall, as in vaginal hysterotomy, and then rely upon palliative treatment.

**Lateral Displacements of the Pregnant Uterus.**—Slight degrees of lateral displacement of the uterus during pregnancy are relatively frequent, but usually have no effect upon its course and do not give rise to symptoms. It should, however, be borne in mind that similar conditions are

sometimes mistaken for tubal pregnancy. In two cases reported by Löhlein and Gottschalk the uterus had undergone a considerable degree of torsion, its left margin showing marked rotation toward the right, which in the second case was associated with retroflexion.

**Prolapse of the Pregnant Uterus.**—Impregnation in a totally prolapsed uterus is very rare on account of the difficulties attending a successful coitus, but if the prolapse is only partial it is comparatively frequent. In such cases the cervix, and occasionally a portion of the corpus, may protrude to a greater or lesser extent from the vulva during the early months, but as pregnancy progresses the uterus gradually rises up in the pelvis, and, as soon as it has passed beyond the superior strait, prolapse is no longer possible. On the other hand, if it retains its abnormal position, symptoms of incarceration appear during the third or fourth month, and abortion is the inevitable result, there being no cases on record in which pregnancy has progressed to term with the uterus outside of the body.

If there is a tendency towards prolapse during pregnancy, the uterus should be replaced and held in position by a suitable pessary. If, however, the pelvic floor be too relaxed to permit its retention, the patient should be kept in a recumbent position as far as possible until after the fourth month. When the cervix reaches to or slightly protrudes from the vulva, the greatest cleanliness is necessary, as several cases

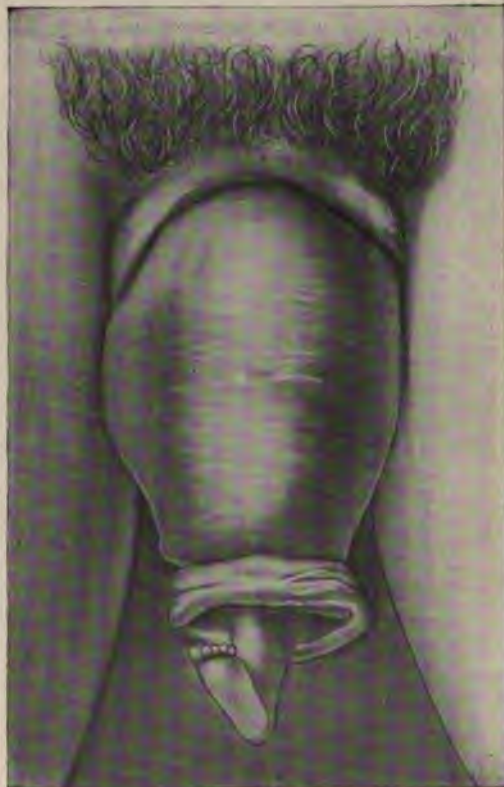


FIG. 467.—PROLAPSED PREGNANT UTERUS (Wagner).

of fatal infection have been reported as occurring even without any internal examination. If the uterus lies outside of the vulva and cannot be replaced, it should be emptied of its contents.

When the vaginal outlet is markedly relaxed, the congested anterior or posterior vaginal walls sometimes prolapse during pregnancy, although the uterus may still retain its normal position. This condition may give rise to considerable discomfort and interfere with locomotion. It is not amenable to treatment until after delivery. At the time of labor these structures



may be forced down in front of the presenting part and interfere with its descent. When this occurs they should be carefully cleansed and pushed back over it.

In rare instances a hernial protrusion may occur through the vagina, the anterior or posterior wall forming part of the sac. Such a *vaginal enterocele* may form a tumor of considerable size filled with intestines. Hirst has collected 27 instances from the literature. If the condition occurs during pregnancy, the protrusion should be replaced and the patient kept in the recumbent position. At the time of labor it may seriously interfere with the advance of the head. In such cases the mass should be pushed up if possible, and, when this cannot be done, it should be held out of the way as well as may be, and the head delivered past it.

**Hypertrophic Elongation of the Cervix.**—An abnormally elongated cervix seriously interferes with the occurrence of conception, but, as a rule,

does not complicate the course of pregnancy or labor. The canal usually becomes shorter and more dilatable as term is approached. In one of my patients the vaginal portion of the cervix in the early months was 5 centimeters in length and the external os protruded from the vulva, whereas later it had undergone marked softening and become reduced to normal dimensions, so that labor occurred spontaneously.

**Acute Cœdema of the Cervix.**—In very rare instances the cervix, particularly its anterior lip, may become acutely cœdematous and attain such proportions as to pro-



FIG. 468.—PREGNANCY IN HORN OF UTERUS CONTAINED IN INGUINAL CANAL (Eisenhart).

trude from the vulva. This condition is referable to an angio-neurosis, and may disappear almost as suddenly as it developed. Jolly, in 1904, was able to collect 10 cases from the literature.

**Hernia.**—Pregnancy occurring in women suffering from *inguinal hernia* is not influenced by the condition, although, owing to the increased

intra-abdominal pressure, the previous defect may become aggravated. Generally speaking, the hernia should be treated palliatively by rest and the use of a truss, operative treatment being deferred until after delivery.

Very exceptionally, the uterus may form part of the contents of an inguinal hernia, and, indeed, several cases are on record in which conception has occurred under such circumstances. Full literature upon the subject will be found in the articles of Adams and Eisenhart, the latter having reported a case in which one horn of a five months' pregnant bicornuate uterus occupied the right inguinal canal.

*Umbilical herniæ* are frequently noted during pregnancy, but are usually without effect upon the condition. During the early months the uterus is not in the neighborhood of the hernial opening, while later, when the fundus reaches its level, it is usually too large to gain access to it; but when the abdomen is markedly pendulous, such an occurrence is not beyond the



FIG. 469.—HERNIA OF PREGNANT UTERUS (Adams).

range of possibility, and several such instances are on record. Much more common are the cases in which the cicatrix of an abdominal incision yields to the increased intra-abdominal pressure incident to pregnancy, and along the linea alba is formed a hernial sac into which the pregnant uterus often makes its way, being then covered merely by a thin layer of skin, fascia, and peritoneum.

A similar condition is occasionally observed in women suffering from marked *diastasis of the recti muscles*. Fig. 469 represents a patient in whom a hernia of this kind occurred suddenly during labor. Ordinarily, such herniæ have no effect upon pregnancy, although they may add markedly to the discomfort of the patient. Temporary relief is frequently



obtained by holding the uterus in its normal position by a properly fitting bandage. At the time of labor, owing to the loss of muscular tone in the abdominal walls, the second stage is liable to be prolonged, and the employment of forceps is often called for.

### DISEASES OF THE DECIDUA

In non-pregnant women the endometrium is frequently the seat of lesions which are grouped together clinically under the general heading of *endometritis*. Careful histological examination shows, however, that the term is usually a misnomer, as the changes are generally trophic rather than inflammatory in character. The most important varieties are:

Hyperplastic endometritis—general hyperplasia, localized hyperplasia, polypoid growths.

Glandular endometritis—glandular hyperplasia.

Interstitial endometritis—general hypoplasia.

Acute and subacute endometritis—inflammatory changes.

These conditions are prototypes of more or less similar lesions occurring in the decidua, except, of course, that the latter are modified by the histological characteristics incident to pregnancy.

In the vast majority of cases, as was first pointed out by Veit, the decidual affection represents the extension of a lesion already existing at the time of pregnancy, conception occurring in a uterus affected by one of the various forms of so-called endometritis. In rare cases, however, it may be primary.

It is generally believed that endometritis is almost necessarily associated with sterility, the abnormal secretion of the uterine glands interfering with impregnation, and, even if conception occurs, the diseased mucosa does not offer a favorable nidus for the implantation of the ovum. Generally speaking, this belief is justified whenever the endometrium is the seat of an acute inflammatory process, and every physician can recall instances in which sterility persisted until more or less normal conditions were restored. On the other hand, slight degrees of chronic endometritis, or of hyperplastic condition, do not, as a rule, interfere with conception.

**Diffuse Thickening of the Decidua.**—Hegar, Kalténbach, Kaschewarowa, and others have described a general hyperplasia of the decidua, in which the membrane, instead of becoming thinner, as is generally the case after the first few months, assumes unusual proportions. The condition frequently results in abortion, as a large part of the nutritive material intended for the fœtus is diverted to nourishing the decidua. After abortion or labor, a thickened decidua may cause abnormalities in the separation of the placenta.

**Localized Thickening of the Decidua (*Decidua Polyposa*).**—In this affection the entire decidua is somewhat thickened, but its characteristic feature consists in the projection of irregularly shaped, knob-like masses from the inner surface. Virchow first described this condition as *decidua tuberosa* or *polyposa*, and considered it to be syphilitic in origin, which, however, is not always the case. Ahlfeld states that it is frequently ob-

served, and Nyulasy of Melbourne has noted more than 100 cases in his own practice. Bulius holds that it occurs but rarely, and I have never met with an instance.

**Glandular Hyperplasia of the Decidua** (*Endometritis Decidua Glandularis*).—Oc-

casional marked hyperplasia of the glandular structures of the decidua is present, and is usually associated with persistence of the glandular ducts. This affection commonly manifests itself by a profuse secretion of clear fluid, which may dribble away as rapidly as it is produced, or be retained in the uterus to be suddenly discharged in large quantities at variable intervals—*hydrorrhœa gravidarum*. The amount of fluid expelled varies considerably, though Ahlfeld has reported a case in which it exceeded 500 cubic centimeters on several occasions. This condition precludes the fusion of the decidua vera and reflexa, and therefore in the occasional instances in which it continues throughout pregnancy it must be assumed that these structures had

failed to unite as usual.

During the last few years considerable discussion has arisen concerning the nature of *hydrorrhœa gravidarum*. Stoeckel, Myer-Rüegg, and others believe that it does not result from changes in the decidua, but is due to premature rupture of the foetal membranes. The latter observer, in 1904, collected 15 cases from the literature in which a period varying from fifty to



FIG. 471.—ENDOMETRITIS DECIDUA CYSTICA (Breus).



FIG. 470.—DECIDUA POLYPOSA (Bulius).

one hundred and twenty days had elapsed between the rupture of the membranes and the termination of pregnancy. In such cases there occurs a



obtained by holding the uterus up, and examination of the placenta bandage. At the time of the delivery, the placenta is usually retracted about the maternal end of the abdominal walls, the second stage of labor is too small to inclose the foetus. Van der Meer, and bases his belief upon the analysis of the liquor amnii in which differs from the liquor amnii in not containing albuminous materials

#### DISEASES

In non-pregnant women, lesions which are grouped as *endometritis*. Careful histological examination is usually a misnomer, than inflammatory in character. *Endometritis cystica*.

Hyperplastic endometritis. Under this heading Hegar, Ahlfeld, in which large portions of the decidua are changes similar to those which occur

Glandular endometritis

Interstitial endometritis

Acute and subacute endometritis

These conditions are producing in the decidua, except in histological characteristics from

In the vast majority of cases, decidual affection represents the time of pregnancy, coming of the various forms of so-called may be primary.

It is generally believed that with sterility, the abnormal secondary impregnation, and, even if some offer a favorable nidus for the impregnation, this belief is justified when acute inflammatory process, which sterility persisted until menopause. On the other hand, slight degrees of condition, do not, as a rule, interfere

**Diffuse Thickening of the Decidua.**—Rowa, and others have described a condition in which the membrane, instead of being thin after the first few months, assumes a frequently results in abortion, and the foetus is diverted from the normal course of labor, a thickened decidua may be the cause.

**Localized Thickening of the Decidua.**—In this affection the entire decidua is swollen, the feature consists in the projection of the decidua from the inner surface. Virchow has described it as *tuberosa* or *polyposa*, and considered it as a normal surface covered with a yellowish growth, however, is not always the case.

uterine glands may become occluded, which project from the surface of the decidua. The affection has been described as *endometritis cystica*.

Under this heading Hegar, Ahlfeld, in which large portions of the decidua are changes similar to those which occur



ENDOMETRITIS. X 280.

to the lateral margins of the uterus. In such cases the decidua vera and chorion are not affected, but consider that it interferes with the normal course of labor.

Acute inflammatory lesions of the decidua are a frequent cause of abortion. In such cases the decidua vera and chorion are not affected, but consider that it interferes with the normal course of labor.

able to demonstrate the presence of cocci in cultures. These observations are usually very inflammatory process preceded, or was followed by a history, cases having been reported by others. Reference has already been made to the association of gonorrhoea and other diseases.

trated with leukocytes, and presents the typical picture of acute inflammation, with here and there areas of necrosis. More commonly, however, the changes are less marked, and only a few collections of leukocytes are seen lying between the decidual cells.

Maslowsky and Neumann have been able to demonstrate the presence of gonococci in several cases of acute inflammation of the decidua; and it is probable that such conditions are quite common.

The various forms of endometritis decidua complicating pregnancy are the most important factors in the causation of spontaneous abortion, and the existence of some one of them should be suspected whenever the patient complains of a sensation of weight in the lower abdomen associated with a slightly blood-stained or dirty brownish discharge, particularly when there is a history of gonorrhœal infection or of repeated abortions.

It is permissible to assume that such conditions, particularly the hyperplastic forms, play a part in the production of placenta prævia, or, when the organ is implanted normally, seriously interfere with the mechanism of its separation.

Endometritis is not amenable to treatment during pregnancy. Should the patient present the slightest sign of its existence after abortion or childbirth, appropriate measures should at once be instituted, since the condition frequently persists, and may become seriously aggravated in a subsequent pregnancy.

**Metritis.**—Unless it results from infection, metritis is a very rare complication of pregnancy, and when it exists was usually present before conception. It predisposes to abortion and is not amenable to treatment during pregnancy.

**Peri-uterine Inflammation.**—When pregnancy occurs in women suffering from peri-uterine inflammation, considerable discomfort may result from the stretching of old adhesions. Not uncommonly abortion results. Now and again the inflammatory changes undergo exacerbation during pregnancy, and may eventuate in abscess formation, which is accompanied by the usual symptoms of pelvic peritonitis. Very exceptionally rupture may occur and give rise to acute peritonitis, which usually ends fatally unless appropriate operative measures are promptly undertaken.

**Pregnancy Complicated by Tumors.**—Pregnancy is occasionally complicated by the presence of ovarian or uterine tumors. Although, as a rule, they do not materially affect its course, they frequently give rise to serious dystocia at the time of labor, and will therefore be considered in detail in Chapter XXXII.

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## CHAPTER XXVIII

### DISEASES AND ABNORMALITIES OF THE OVUM

Any portion of the ovum—chorion, amnion, placenta, or foetus—may be the seat of disease, or may present abnormalities. In many instances the morbid process is limited to a single portion, while in others a large part, or even the ovum as a whole, may be implicated. Accordingly, we shall take up successively those lesions or abnormalities which are limited to the chorion, amnion, or placenta; next, those in which the entire ovum, and finally those in which the foetus alone is affected.

### DISEASES OF THE CHORION

**Hydatidiform Mole.**—In this condition, also known as vesicular mole, cystic degeneration of the chorion, or myxoma chorii, the terminal extremi-



FIG. 473.—HYDATIDIFORM MOLE (Bumm).

ties of the chorionic villi are converted into transparent vesicles with clear, viscid contents. These vary in size from minute bodies a millimeter or less in diameter to cystic structures the size of hazelnuts, and hang in clusters from the villous stems, to which they are connected by thin pedicles, giving to the external surface of the chorion a grape-like appearance. The formation may involve the entire periphery of the

membrane, but more frequently is limited to portions of it.

It is generally stated that the condition was first described by Schenck

von Grafenberg in 1565, but Kossmann has pointed out that *Ætius*, of Amida, in the early part of the sixth century, wrote intelligently about an hydatidiform mole, although he had no clear idea of its nature.

Owing to its peculiar appearance and the fact that it frequently contained no trace of a *fœtus*, the hydatidiform mole was a source of not a little speculation to the early writers upon medicine, and all sorts of theories were advanced concerning its origin. As the name implies, the condition was long considered to be analogous to the hydatid cysts observed in other parts of the body, Goeze, Percy, and others believing that the vesicles contained worm-like structures. De Graaf held that the vesicles were



FIG. 474.—SECTION OF HYDATIDIFORM MOLE, SHOWING PROLIFERATION OF SYNCYTIIUM AND LANGHANS'S CELLS.  $\times 75$ .

S., syncytium; V., normal chorionic villi; Z., Langhans's cells.

mature ova, while some authors thought that each represented an early pregnancy. It is probable that many of the extraordinary cases of multiple gestation recorded in the early literature, such as that of the Countess Hagenau, who was believed to have given birth to 365 embryos at a single labor, were really instances of hydatidiform mole.

The true nature of the affection was first recognized by Velpeau and Madame Boivin in 1827, and since then it has been universally admitted to be a disease of the chorion. Numerous theories were advanced as to the nature of the lesion, until Virchow in 1853 stated that the process was essentially a myxomatous degeneration of the connective tissue of the



chorionic villi, and designated it as *myxoma chorii*. This view obtained immediate acceptance and held its ground until 1895, when Marchand demonstrated that the essential feature of the affection was to be found not so much in the stroma as in the epithelial covering of the villi. He showed that both the syncytium and Langhans's layer of cells underwent profuse and irregular proliferation, penetrating Nitabuch's fibrin layer and making their way into the depths of the decidua, and not infrequently into the uterine musculature as well. At the same time the blood-vessels of the terminal villi disappeared and the stroma degenerated, so that in advanced cases its cells became necrotic and their nuclei failed to take up the usual histological stains. Moreover, inasmuch as the fluid contents of the vesicles failed to give the characteristic reaction for mucin, Marchand felt justified in attributing them to oedema.

This work obtained almost immediate acceptance, and was promptly confirmed by many investigators, among whom Neumann, Fraenkel, Pick, Ouvry, Schwab, and Larrier and Brindeau may be mentioned. Fig. 474 represents a section through one of my specimens, all of which abundantly confirm Marchand's view.

With the discovery that the so-called chorio-epithelioma resulted from a malignant proliferation of the epithelial elements of the chorion, and particularly that it was preceded in from one third to one half of the recorded cases by the expulsion of an hydatidiform mole, great interest arose as to the nature of the latter condition and the relation which it bore to the production of the former. The similarity in the microscopic structure of the two pathological processes made it apparent that there must be a genetic relationship between them, and the question arose whether it existed in all cases.

Neumann, in 1897, held that it was possible to differentiate between two forms of hydatidiform mole, one of which was and the other was not followed by the development of a chorio-epithelioma. He considered that in the former the proliferating epithelium invaded the stroma, while in the latter it was limited to the periphery of the villus. His observations, however, have not been confirmed, although Pick, Findley, Larrier and Brindeau, and most subsequent writers believe that moles may occur in one of two forms—benign or malignant—but that the differences are biological rather than histological, so that it is impossible to predict the outcome of a given case by microscopical examination.

Marchand, in his original article, stated that in many instances the ovaries were likewise the seat of cystic changes. Stoeckel, in 1902, showed that one or both ovaries might become converted into polycystic tumors of varying size, sometimes attaining a diameter of 10 or 15 centimeters. The individual cysts may vary from a few millimeters to 5 or 6 centimeters in diameter, are filled with clear contents, and are lined by one or more layers of lutein cells. Since then it has become generally recognized that the lutein cell cystoma is a frequent, but not a universal, accompaniment of the condition.

As lutein cystomata do not occur frequently, their association with hydatidiform mole has given rise to a great deal of discussion, certain



writers holding that they stand in some ætiological relation to the mole; others that they are secondary to it; while a third group, represented by Wallart and Seitz, considers that similar, but less pronounced, changes occur in normal pregnancy. I am not prepared to express a decided opinion upon the subject, but consider that the demonstration by Fraenkel and Santi, that lutein cystomata sometimes undergo spontaneous involution within a few months after the expulsion of the mole, indicates that there must be a genetic relationship between the two processes. In one of my patients, whose second pregnancy ended in the expulsion of a large mole, both ovaries were converted into polycystic lutein tumors, 15 centimeters in diameter. They were successfully removed after laparotomy, and constitute my sole experience with this type of tumor.

*Causation.*—Virchow and Veit agree that the development of the condition is dependent upon endometritic changes. At the 1901 meeting of the German Gynecological Congress Aichel stated that he had been able to produce the condition experimentally in dogs by destroying the vessels going to the decidua, and thereby interfering with the nutrition of the chorionic villi. On the other hand, Marchand and most recent writers are inclined to consider the changes in the endometrium as secondary, and to search for the initial factor in the ovum itself. Durante considers that the condition is due to endarteritis of the villous vessels. Plausibility is lent to the view that the primary process originates in the ovum by the fact that in rare instances of twin pregnancy one ovum may be perfectly normal, while the other presents the lesion in question. Mme. Boivin was acquainted with the fact, and cases have been reported by Birnbaum and Falgowski. It is hardly probable, if changes in the endometrium were the primary cause, that the vesicular change would be limited to one ovum.

*Clinical History.*—Hydatidiform mole is a rare disease, occurring, according to Madame Boivin, once in 20,000 cases. On the other hand, the statistics of Williamson would indicate that it may be found about once in 2,400 cases. It may occur at any period of reproductive life, but is particularly frequent in the third decade, having been noted between the twentieth and thirtieth years in 41 and 38 per cent. of the cases collected by Dorland and Kehrer respectively. It likewise appears with comparative frequency after the fortieth year—in 16 and 22 per cent. of the cases, according to the same authors.

The process usually comes on early in pregnancy, rarely making its appearance after the third month. When it develops comparatively late it does not implicate the entire chorion; but whenever a considerable portion of the membrane is involved, atrophic changes affecting the fœtus are constantly found, and its development is materially influenced even when the disease is relatively mild in character. In the former class of cases the fœtus dies at an early period, and often undergoes complete dissolution, all trace of it disappearing except the maternal end of the umbilical cord. As the chorionic villi are nourished by the maternal blood, the mole usually continues to grow after the death of the fœtus, and may attain considerable proportions, though spontaneous expulsion is rarely delayed after the sixth month.



The clinical history is very characteristic. The uterus enlarges much more rapidly than usual, so that the fundus is often found at the level of or above the umbilicus in a woman who gives a history of being only a few months pregnant. After a longer or shorter period more or less profuse hæmorrhage occurs, which persists until the mole is cast off spontaneously or removed by the physician.

In a small number of cases, the hypertrophic villi invade the uterine wall, following the course of venous channels, and in extreme instances the entire muscularis may become disintegrated. This happens in what is known as the destructive mole, characteristic examples of which have been reported by Krieger, Volkmann, Jarotsky, and Waldeyer. Now and again the growth reaches the peritoneal surface of the uterus and gives rise to perforation, followed by fatal intra-peritoneal hæmorrhage. This complication was observed by Wilton, Madame Boivin, Ouvry, and others.

In rare instances, at varying periods after the expulsion of the mole, small purplish or reddish tumors may appear in the vagina or about the vulva. On microscopic examination, after excision, these are found to consist for the most part of blood, through which are scattered dropsical villi showing the characteristic epithelial changes. In a number of cases recorded, the uterus was perfectly normal, and complete excision of the nodule was followed by permanent recovery. The question has accordingly arisen whether such tumors represent metastases from a chorio-epithelioma



FIG. 475.—HYDATIDIFORM MOLE.  $\times 50$ .

Invasion of blood-vessel. D. V., dropsical villus; Syn., proliferating syncytium  
U. W., uterine wall; V., vein.

or a malignant hydatidiform mole, or whether they are merely due to the accidental transportation of particles of a benign growth. Neumann and Schmidt take the former, while Pick and Schlagenhauser incline to the latter view. The observations of Veit, Poten, and myself, concerning the transportation of villi in normal pregnancy, lend a certain probability to the latter theory, although the question must remain to be settled by future investigations (see Fig. 475).

Aside from the possibility of the development of a chorio-epithelioma, which occurred in 16 per cent. of the 210 cases analyzed by Findley, the hydatidiform mole is a serious affection, since Dorland noted an immediate mortality in 10 per cent. of the 100 instances which he collected from the literature, death being due to hæmorrhage at the time of operation in 3 per cent., to perforation of the uterus in 2 per cent., and to infection in 5 per cent. of the cases.

*Diagnosis.*—Hydatidiform mole should always be suspected when hæmorrhage occurs in a patient whose uterus is considerably larger than it should be for the duration of pregnancy, though in not a few cases similar symptoms are noted in hydramnios. A positive diagnosis may be made when one finds one or more vesicles in the uterine discharges, or when the finger introduced through the cervical canal is able to palpate the characteristic grape-like masses.

*Treatment.*—Owing to its inherent danger, but especially to the possible subsequent development of a chorio-epithelioma, the uterus should be emptied as soon as a positive diagnosis is made. By means of a gauze pack or a steel dilator, the cervix should be dilated sufficiently to admit two fingers, with which the growth is peeled off from the uterine wall and then removed. Care should be taken that the manipulations are made as gently as possible in order to avoid a possible perforation of the uterus, whose walls are likely to have been weakened by the invasion of the growth. After removal of the mole, the uterine cavity should once more be explored to make sure that it is thoroughly empty.

Every woman who has suffered from a hydatidiform mole should be carefully watched for the next few months, and if hæmorrhage makes its appearance the uterus should be curetted and the scrapings subjected to microscopic examination; and, if the lesions characteristic of chorio-epithelioma are found to be present, immediate hysterectomy is imperative, in the hope of avoiding metastases. On the other hand, as has already been pointed out, vaginal or vulval metastases may occur without any apparent involvement of the uterus. Under such circumstances, if the uterine scrapings are negative, the metastases should be excised, but the uterus left in place, as the history of similar cases shows that the majority of the patients recover permanently.

**Chorio-epithelioma** (*Deciduoma Malignum*).—This term is applied to a very malignant variety of uterine tumor which develops after a full-term labor, abortion, or hydatidiform mole, and in rare instances before the last is expelled from the uterus. The nature of the growth has given rise to a great deal of discussion, and various appellations have been suggested for it, the most important being sarcoma deciduo-cellulare, syncytioma malignum, and carcinoma syncytiale.

Sänger read his first paper upon the subject in 1892, and based his report upon the following case: A woman, twenty-three years of age, aborted in the eighth week and died seven months later. At autopsy four large, soft, reddish, spongy tumors were found in the uterine wall, with metastases exhibiting similar characteristics in the lungs, diaphragm, tenth rib, and right iliac fossa. Microscopic examination showed that the tumor



was made up in great part of blood spaces bounded by large cells, which Sanger considered decidual in origin. The metastases presented a similar appearance and had resulted from the transportation of tumor masses through the venous channels. As Sanger believed that the tumor was derived from decidual cells and was therefore of connective-tissue origin, he designated it *decidual sarcoma* or *sarcoma uteri deciduo-cellulare*. The appearance of his monograph in 1893, in which was collected all that was then known upon the subject, created profound interest, and was soon followed by the publication of many similar cases.

In 1895 I published a monograph upon the subject, in which I reported a case and collected 24 others from the literature. My patient was a



FIG. 476.—CHORIO-EPITHELIOMA, SHOWING ALVEOLAR ARRANGEMENT OF PRIMARY TUMOR.  $\times 60$ .

colored woman who had a spontaneous full-term labor. A week later she noticed a small painful nodule upon the right labium majus. This resembled a hæmatoma in appearance, rapidly increased in size, and within two weeks became as large as a hen's egg. Shortly afterward it underwent necrotic changes, which were accompanied by a profuse, foul-smelling discharge. The patient gradually grew worse, eventually developed a cough and bloody expectoration, and died six months after delivery. The nature of the vulval tumor was not suspected during life, but at autopsy the lungs were found to be studded with large numbers of metastases of varying size, which resembled placental tissue in appearance. Similar but smaller growths were present in the kidneys, spleen, and ovary, while a small nodule about 1 centimeter in diameter was found in the uterus.

Microscopic examination showed that the uterine growth and the metastases were made up in great part of blood spaces, whose walls were formed by large clear cells with definite vesicular nuclei. At the margins of the primary growth, invading the adjacent musculature, were large masses of

syncytium; the nature of the individual cells was not so clear, although I was inclined to consider them due to transverse and oblique sections through the syncytial strands.

The same year Marchand wrote a most important monograph upon the subject. He identified the protoplasmic masses with the syncytium, and the individual cells with those of Langhans's layer. At that time it was generally believed that the former was of maternal and the latter of foetal origin; accordingly he held that the tumor was epithelial in origin, and was composed partly of maternal and partly of foetal tissue. Hence it followed that such tumors could not correctly be described as deciduomata or de-

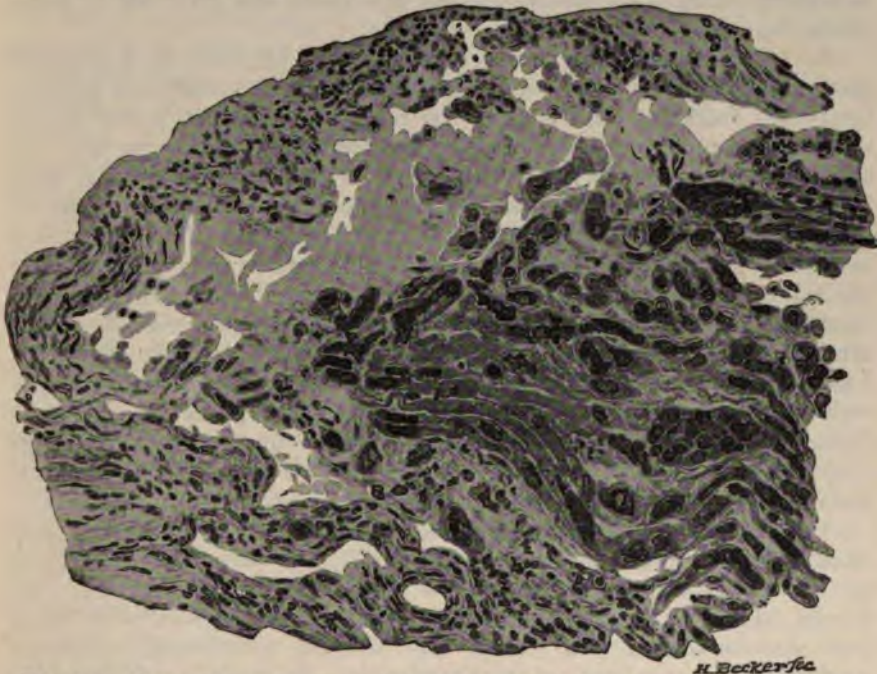


FIG. 477.—CHORIO-EPITHELIOMA, SHOWING SYNCYTIAL MASSES INVADING A VENOUS CHANNEL.

cidal sarcomata; and, after it had been demonstrated that both layers of the chorionic epithelium—syncytium as well as Langhans's layer—were foetal in origin, Marchand (1898) proposed the term *chorio-epithelioma*, which has since been generally accepted.

Marchand's conclusions have received abundant confirmation at the hands of all who have studied the subject, with the exception of Veit and certain English authorities. For a time these held that the tumor was simply a sarcoma whose cells had undergone changes in appearance under the influence of pregnancy; but in the discussion following Teacher's admirable paper before the London Obstetrical Society in 1903 this view was abandoned and Marchand's teachings fully accepted.

The monographs of Säger and Marchand were the beginning of an



extensive literature upon the subject, which has rapidly increased in volume. Thus, Teacher and Briquel in 1903 were able to collect 188 and 254 cases respectively, and Frank in 1906 analyzed 28 cases which had been reported in America; while Risel in 1907 and Veit in 1908 carefully reviewed the entire subject.

Risel, working in Marchand's laboratory, contends that chorio-epithelioma may occur in a typical and an atypical form. In the former the tumor cells present an appearance identical with that observed in the chorionic epithelium in early pregnancy, while in the latter the foetal cells merely infiltrate the uterine wall, without necessarily giving rise to a true tumor formation. Both varieties are equally malignant and give rise to metastases.

In other instances, the primary growth may originate in a pregnant tube, as observed by Davidson and myself, or in the ovary, as reported by Iwase, Fairbairn, and others. In the latter event, it is not known whether the process was preceded by an ovarian pregnancy or not. In still other cases, as reported by Schmorl, Hübl, Findley, and others, there is no primary growth in the uterus, tubes, or ovaries, but the patient nevertheless died from metastases in various organs. At first it was attempted to explain such an occurrence by assuming that the primary growth was limited to the placenta, particles of which became broken off and were carried into the circulation, giving rise to metastases wherever they were arrested, while the primary tumor itself was cast off with the afterbirth. Later, however, as the frequency of the "deportation" of chorionic villi became more fully recognized, it was assumed that metastases might be formed in any case in which the chorionic epithelium possessed malignant properties. Poten and Vassmer have reported a case in which vaginal metastases appeared while an hydatidiform mole was still in the uterus.

The chorio-epithelioma rapidly gives rise to abundant metastases, particularly in the lungs, vagina, and brain. They develop along the course of venous channels, which is explained by the tendency of the foetal ectodermal cells to erode, and eventually invade, the blood-vessels with which they come in contact. In the 52 cases collected by Dorland, metastases were observed in the lungs of 78.38 per cent., in the vagina of 54 per cent., and in the kidney, spleen, and ovary of 13.5 per cent., of the liver, broad ligament, and pelvis respectively 10.8 per cent., and in the brain 5.4 per cent. The vaginal metastases are of particular significance, and occasionally are the only manifestation of the condition. In some cases, as reported by Hörmann and others, their excision may be followed by complete recovery.

Runge in 1903 pointed out that lutein cystomata were sometimes observed in the ovaries. Upon analyzing 63 cases of chorio-epithelioma in which the condition of the ovaries was described, he found such formations in 24 instances; but, just as is the case in hydatidiform mole, neither he nor subsequent investigators have been able to adduce a satisfactory explanation of their significance.

In 1902 Wlassow and Schlangenhäüfer made a contribution, which for a time threatened to overturn our ideas concerning the significance and



mode of origin of chorio-epitheliomata. They described generalized metastases following certain teratomata of the testicle, which were made up of syncytium, Langhans's cells, and even of structures resembling chorionic villi. Their observations have been abundantly confirmed by Risel, Teacher, Frank, and others; while Pick and others have reported similar conditions associated with ovarian teratomata.

In such cases, Schlangenhäüfer assumed that portions of foetal membranes had been included in the teratoma, and suddenly began to proliferate after lying dormant for years. Risel and all subsequent writers, on the other hand, hold that such an assumption is not necessary, and consider that such a formation may develop from undifferentiated foetal ectoderm contained in the teratoma.

*Clinical History.*—Chorio-epithelioma may occur at any age during the childbearing period, and always follows a pregnancy, whether the latter terminates in full-term labor, abortion, or hydatidiform mole, the last association being noted in nearly 50 per cent. of the cases. In several instances it originated from a tubal or ovarian pregnancy.

Ordinarily there is no suspicion of the existence of the growth during pregnancy, or even during the first few weeks after delivery. In a small number of cases hæmorrhage in the latter part of the puerperium may be the first indication of its existence, though this symptom is usually lacking. Occasionally a much longer period may elapse, and Krösing has collected 16 instances in which a period of latency, varying between 1 and 9 years, was noted. In more than one half of the cases the first indication is the appearance of vaginal or vulval metastases. These are usually not noted until some weeks or months after the puerperium, though in Poten and Vassmer's case they appeared before the extrusion of the mole, and in my case one week after a full-term labor. The development of metastases in the lungs is usually associated with pulmonary symptoms, cough, and bloody expectoration. Occasionally, as reported by Hörmann and others, the growth may perforate the uterine wall and give rise to fatal intra-peritoneal hæmorrhage. Unless removed by operative procedures, the tumor rapidly causes death, the majority of patients succumbing within the first year. Indeed, it may be said that, in general, this is the most rapidly fatal malignant growth with which we are acquainted, though occasionally cases are encountered in which permanent cure follows a simple curettage, but such a favorable outcome occurs so rarely that it does not justify the postponement of radical operative treatment.

*Diagnosis.*—In a considerable number of cases the diagnosis is not made until uterine hæmorrhage, occurring at a varying period after the puerperium, necessitates curettage, when the microscopic examination of the scrapings reveals characteristic changes. In other instances the occurrence of vaginal metastases is the first indication of the existence of the growth.

The possibility of its development should always be borne in mind whenever a woman has expelled a hydatidiform mole, and the subsequent appearance of hæmorrhage, or of other more obscure symptoms, should be an imperative indication for curettage and the microscopic examination of the scrapings.



**Treatment.**—If curettage reveals the existence of characteristic lesions, immediate hysterectomy is imperative. On the other hand, when vaginal metastases are present, the indications for radical operation are not so clearly marked, as we know that in some such cases the uterus contains no growth, and that the excision of the vaginal tumors may be followed by complete recovery. If, however, the uterus is also involved, hysterectomy as well as excision of the metastases is indicated, though the chances for ultimate recovery are very slight.

**Diffuse Myxoma of the Chorion.**—Breslau and Eberth have called attention to a rare affection of the chorionic membrane, in which its connective tissue layer undergoes myxomatous degeneration and becomes converted into a jelly-like substance analogous to the Whartonian jelly of the cord. This layer may attain a thickness of 4 to 5 millimeters, but does not appear to exert any special influence upon pregnancy.

**Myxoma Fibrosum of the Chorion.**—Virchow called attention to the fact that a greater or lesser number of the chorionic villi, which enter into the formation of the placenta, may lose their original structure and take part in the formation of a tumor made up of dense connective tissue with larger or smaller areas of myxomatous tissue scattered through it. As the change is limited to the placenta, its consideration will be deferred until the tumors of that structure are studied.

## DISEASES OF THE AMNION

**Hydramnios.**—By hydramnios is understood the presence of an excessive quantity of liquor amnii. Exactly when the proper limit is passed cannot be stated with accuracy, for the reason that the authorities do not agree as to the amount to be considered normal, Fehling placing it at 680 and Gassner at 1,877 cubic centimeters, though, generally speaking, a quantity greater than 2 liters may certainly be considered excessive.

Minor degrees of hydramnios—2 to 3 liters—are common, but the more marked grades are not frequent. In rare cases the uterus may contain an almost incredible amount of liquor amnii, Küstner having observed 15 liters, and Schneider 30 liters at the fifth and sixth months of pregnancy respectively. In most cases the increase in the amount of amniotic fluid is quite gradual, but exceptionally it takes place very suddenly, so that the uterus may become immensely distended within a few days—*acute hydramnios*.

The fluid in hydramnios is usually identical in appearance and composition with that normally present in the amniotic cavity, although Prochownick states that the former occasionally contains a slightly increased amount of urea.

**Ætiology.**—As was said when the physiology of the fœtus was dealt with, the amniotic fluid is normally derived from the fluids of the mother, which have been modified by the secretory action of the amniotic epithelium; while the fœtal kidneys take no part in its production, except under abnormal conditions. This being the case, it is manifestly impossible to

give an explanation for its excessive production which will be universally applicable.

Generally speaking, writers upon the subject state that the excess of amniotic fluid may be derived from several sources—from the foetus, from the mother, from both foetus and mother, and in rare cases from the amnion itself.

In something less than one half of the cases careful examination of the foetus after death reveals the presence of some abnormality which may or may not bear a causal relation to the disease. Thus, hydramnios is sometimes, though not always, noted when the foetus presents some abnormality or deformity, particularly hemicephalus or spina bifida. Under such circumstances, it is believed that the superabundant fluid is the result of an excessive urinary secretion, which is brought about by the stimulation of cerebral or spinal centers which have been deprived of their usual coverings, just as happens in the *pigûre* experiments of the physiologists. Hydramnios is also found associated with other deformities, such as hare-lip, the various varieties of club-foot, ectopia of the bladder, etc., as well as certain tumors of the kidneys.

More frequently, however, the abnormality which is supposed to give rise to hydramnios is to be found in lesions which cause obstruction to the circulation either in the cord or within the foetus. In other instances the condition is attributed to renal changes or to abnormalities in the cutaneous functions.

Sallinger has shown that an obstruction to the circulation in the umbilical vein is accompanied by an exudation of fluid from the external surface of the umbilical cord and from the foetal surface of the placenta. This he attributed to the persistence of the so-called vasa propria of Jungbluth, which, springing from the foetal end of the cord, lie between the chorion and amnion and usually become obliterated in the second half of pregnancy. Analogous observations have been made by Levison. According to Franqué, oblitative changes in coats of the arteries of the chorionic villi may lead to similar results. Leopold and Bar have shown that the obstruction may be due to stenosis or thrombosis of the umbilical vein, while Fehling has attributed it to torsion of the cord.

More frequently the obstruction lies within the foetus. Thus Opitz observed cirrhotic changes in the liver in all of his cases. Others have attributed it to syphilitic changes, though my experience leads me to believe that lues is an unimportant factor, as hydramnios does not appear to occur much more frequently in syphilitic than in normal children. In a considerable proportion of cases the obstruction to circulation is due to cardiac abnormalities. Thus, Woerz found the right auricle almost entirely occluded by a rhabdomyoma. Bar observed tricuspid insufficiency and stenotic changes about the pulmonary arteries; Lebedeff, aortic stenosis, and Nieberding, a narrowing of the ductus Botalli.

Many authorities believe that hydramnios is due to an excessive urinary secretion resulting from renal or cardiac lesions. As has already been pointed out, this mode of origin cannot be accepted for all cases. Opitz thought he had demonstrated that in hydramnios the liquor amnii con-



tained a lymphagogue substance, which is normally absent. He considered that its presence in the tissues of the foetus resulted in the extraction from the intervillous spaces of the placenta of a greater amount of fluid than usual. This necessitated increased exertion on the part of the heart, which eventually resulted in its hypertrophy. As a consequence a larger amount of fluid circulated through the kidneys, giving rise to an increased urinary secretion.

It is generally believed that the ætiological importance of increased renal activity is strikingly illustrated in hydramnios occurring in single-ovum twins. Wilson (1899) analyzed the histories of 51 cases of hydramnios occurring in multiple pregnancy—46 twins and 4 triplets. Twenty-two of the twins were uniovular in origin, and, when one considers that these are much less frequently observed than double-ovum twins, it is apparent that something connected with the former must exert an appreciable influence in the excessive production of amniotic fluid. In such cases, as a rule, the hydramnios is limited to a single amnion, while the other contains a normal or diminished amount of fluid. At autopsy the heart and kidneys of the foetus suffering from hydramnios are found to be both relatively and actually larger than those of the normal twin. Wilson attributed this difference to the presence in the single placenta of an area of circulation common to both twins, and believed that one, for some reason, received a larger amount of blood than the other, this excess giving rise to cardiac hypertrophy which still further accentuated the condition, and in turn was followed by renal hypertrophy with increased secretion. He considered that the primary cause for the difference in the amount of fluid received by the two twins was to be found in abnormalities of the umbilical cord, by which the flow of blood to one child was rendered more difficult, as in the cases which he analyzed the affected twin always presented some abnormality of that structure—velamentous insertion, excessive length, or marked narrowing.

The mode of production of hydramnios in such cases has been considered in detail by Schatz, Werth, Strassmann, and Küstner. The last-named authority believes that the cardiac hypertrophy comes about in the manner already mentioned, and leads to a still further increase in the amount of circulating fluid. Eventually the heart becomes unequal to its task and insufficiency results, which is followed by signs of obstruction, particularly in the liver, thereby completing a vicious circle. Scheib, on the other hand, considers that the fluid is a transudate through the umbilical vein, which is brought about by the congestion consequent upon failure of compensation.

Some authors consider that the skin plays a not unimportant part in the excessive formation of liquor amnii. Budin in one case was inclined to attribute it to a large nævus, through which he believed excessive exudation occurred. Furthermore, Wilson and others consider that excessive cutaneous activity is oftentimes associated with cardiac hypertrophy.

In a small number of cases inflammatory conditions of the amnion itself are believed to play a part in the production of the condition, leading to increased exudation through that membrane.



Occasionally diseases of the mother which are attended by circulatory disturbances, particularly cardiac and renal affections, or visceral syphilis, lead to œdema of the placenta, with increased transudation into the amniotic cavity. The demonstration by Wolff that nephrectomy in pregnant rabbits was followed by increased renal activity on the part of the foetus, with consequent hydramnios, also indicates the possibility of a similar occurrence in pregnant women suffering from serious renal disease. One or other of the conditions just mentioned may account for the excessive production of amniotic fluid in a considerable proportion of the cases; but at the same time they do not always afford a satisfactory explanation, inasmuch as in many instances careful search fails to reveal the presence of any lesion which can be supposed to play a part in the production of the anomaly.

*Symptoms.*—The symptoms accompanying hydramnios arise from purely mechanical causes, and are due to the pressure exerted by the over-distended uterus upon adjacent organs. The effects are particularly marked in the respiratory functions, and, when the distention is excessive, the patient may suffer from severe dyspnoea and cyanosis, and in extreme cases be able to breathe only in an upright position. Œdema often occurs, especially in the lower extremities and about the vulva.

It is surprising what great degrees of abdominal distention can sometimes be borne by the patient with comparatively little discomfort, although this is the case only when the accumulation of fluid has taken place gradually. On the other hand, in acute hydramnios, a much slighter degree of distention may lead to disturbances sufficiently serious to threaten the life of the patient.

*Diagnosis.*—In moderate degrees of hydramnios palpation and percussion enable one to feel confident that the fluctuant tumor is the distended uterus, in which a readily ballotable foetus can be felt, although its heart sounds are heard with difficulty.

The excessive enlargement of the abdomen due to multiple pregnancy occasionally renders the differentiation from hydramnios almost impossible; particularly, as the latter is a frequent complication of the former condition. In such cases the hydramnios is usually detected, whereas the multiple pregnancy associated with it often passes unnoticed. On the other hand, in a multiple pregnancy not complicated by hydramnios, the diagnosis is comparatively easy, inasmuch as the uterus offers a firm consistence to the touch, and careful palpation will reveal the presence of several foetal poles and an unusual number of small parts, as contrasted with the marked fluctuation and the difficulty of mapping out the foetus in hydramnios.

When the uterine distention is excessive the diagnosis of hydramnios becomes even more difficult, and many cases are recorded in which the condition was mistaken for a large ovarian cystoma, with the result that the contents of the amniotic cavity were evacuated by means of a trocar, or laparotomy was performed. Inquiry as to the possibility of pregnancy and careful examination will generally serve to prevent such an error.

Excessive abdominal enlargement due to ascites can usually be differ-



entiated by the characteristic changes in percussion. In rare instances pregnancy, complicated by a large ovarian cystoma, may be mistaken for hydramnios. In some cases the detection of two tumors—one corresponding to the uterus and the other to the cyst—will permit a correct diagnosis, but in others the condition may escape detection until after childbirth.

*Treatment.*—Minor grades of hydramnios rarely require active treatment. On the other hand, when the abdomen is immensely distended and respiration is seriously hampered, the termination of pregnancy is urgently indicated no matter to what period it may have advanced. In such cases interference is the more justifiable, since experience teaches that premature labor frequently occurs spontaneously if the patient is left alone, and that the children are often so poorly developed or so deformed that their chances of living are minimal.

In such cases the symptoms can be promptly relieved by perforating the membranes through the cervix, after which the amniotic fluid drains off and labor pains set in. When the abdomen has been enormously distended, and the course of labor is particularly rapid, there is an increased risk of atonic hæmorrhage during and just after the completion of the third stage. For this reason the uterus should be carefully watched, and appropriate treatment instituted at the slightest sign of danger.

**Oligo-hydramnios.**—In rare instances the amount of amniotic fluid may fall far below the normal limits, and occasionally be represented by only a few cubic centimeters of clear, viscid fluid.



FIG. 478.—COMPRESSION OF FŒTUS IN OLIGO-HYDRAMNIOS (Ahlfeld)

The ætiology is even less well understood than that of hydramnios. Jaggard, in 1894, reported a case in which the fœtus presented an imperforate urethra with absence of one and cystic degeneration of the other kidney, and he therefore concluded that the lack of amniotic fluid was the result of non-secretion of urine. He likewise collected several instances from the literature, in which the anomaly was associated with complete absence of both kidneys.

When oligo-hydramnios occurs early in pregnancy it is attended by serious consequences to the fœtus, as adhesions may be formed between its external surface and the amnion and give rise to serious deformities. When occurring later, its effect upon the fœtus, though less marked, is quite characteristic. Under such circumstances the latter is subjected to pressure from all sides and takes on a peculiar appearance, and many minor deformities, such as club-foot, are frequently observed (Fig. 478).

In some cases of oligo-hydramnios the skin of the fœtus is markedly

thickened, and presents a dry, leathery appearance. Most authorities attribute this to the lack of amniotic fluid, but Ahlfeld is inclined to believe that it is the cause and not the result of the condition, since the skin lesion may be so marked as to interfere with the normal cutaneous functions and thus do away with one of the sources of the liquor amnii.

**Amniotic Adhesions.**—In oligo-hydramnios, and occasionally even when the liquor amnii is present in normal amounts, adhesions may form between the amnion and the surface of the foetus. According to Simonart, Chaussier in 1812 was the first to direct attention to this condition, and its consequences were further studied by Montgomery, G. Braun, Küstner, Ahlfeld, Chiari, and others.

The effects of amniotic adhesions are variable and depend in great measure upon their location. As a rule, when they develop early in pregnancy they give rise to serious deformities of the foetus. The following abnormalities have been directly traced to the condition: Encephalocele or hemicephalus; fissure of the face, jaw, or lips; fissure of the thorax with ectopia cordis, and eventration with hernia of the umbilical cord.

In other instances, amniotic bands may encircle an extremity of the foetus and so compress it as to lead to strangulation and subsequent spontaneous amputation. Fig. 480 represents



FIG. 479.—ENCEPHALOCLE RESULTING FROM AMNIOTIC ADHESIONS (Ahlfeld).



FIG. 480.—AMPUTATION OF FINGERS BY AMNIOTIC ADHESIONS (Küstner).



FIG. 481.—AMPUTATION OF ARM BY AMNIOTIC ADHESIONS.

intra-uterine amputation of the fingers, and Fig. 481 amputation of the arms, produced in this way. Braun has reported two cases in which the death of the foetus was attributable to strangulation of the umbilical cord



by such bands. Exceptionally amniotic adhesions may give rise to dystocia, and Bardeleben and myself have seen instances in which firm adhesions extending from the placenta to the child seriously interfered with its birth.

**Inflammation of the Amnion.**—Occasionally inflammatory processes implicate the amnion. These are usually associated with similar changes in the chorion and decidua, and result from attempts at criminal abortion or from the extension of an infection that has originated in the decidua.



FIG. 482.—PLACENTA FENESTRATA (Hyrthl).

**Cysts of the Amnion.**—Now and again small cystic structures, lined by typical epithelium, may be formed in the amnion. They generally result from the fusion of amniotic folds with subsequent retention of fluid. Special attention has been devoted to this subject by Ahlfeld. The same observer has

also described a dermoid cyst of the amnion, which does not, however, bear critical examination, inasmuch as the small particles found in it were probably mere concretions.

**Amniotic Caruncles.**—Under this name have been described certain nodules which occur upon the foetal surface of the placenta, as well as upon the free amnion. Usually they appear in the neighborhood of the insertion of the cord as multiple, rounded or oval, opaque elevations, which vary from less than 1 to 5 or 6 millimeters in diameter.

Under the microscope they are seen to be made up of typical stratified epithelium. The lowest layer is cuboidal in shape and is continuous with the amniotic epithelium, while the upper layers become more and more flattened, and stain less and less well as the surface is approached. Such structures were found by my assistant, Solon B. Dodds, in 60 per cent. of a large series of placentæ. As yet we are ignorant of their significance.

## ABNORMALITIES OF THE PLACENTA

**Abnormalities in Size, Shape, and Weight.**—The normal placenta is a flattened, roundish, or discoid organ, which averages from 15 to 20 centimeters in diameter, and from 1.5 to 3 centimeters in thickness. It is relatively larger in the earlier than in the later months of pregnancy, and varies considerably in size at term, though, generally speaking, the thickness is in inverse proportion to its area. Now and again, when inserted in the neighborhood of the internal os, the placenta may take on a horseshoe-like appearance, its two branches running partially around the orifice. In very rare instances, as in one reported by Taurin, it may be a broad annular organ which encircles the uterine cavity just as in carnivorous animals.

The normal full-term placenta on an average weighs about one sixth as much as the child—*i. e.*, somewhere in the neighborhood of 500 grams.

Exceptionally it may be considerably heavier, Levy having reported a number of cases in which it exceeded 1,000 grams in weight. In diseased conditions, on the other hand, this proportion no longer holds good, and in syphilis the placenta may weigh one fourth, one third, or even one half as much as the foetus. In albuminuria similar ratios obtain, which are due almost entirely to the imperfect development of the foetus which characterizes such conditions. The largest placentæ with which we are familiar are observed in cases of general dropsy of the foetus and placenta. In one of my cases of this character the foetus and placenta weighed 1,140 and 1,200 grams, respectively, and Cohen has reported a case in which the latter weighed 2,900 grams.



FIG. 483.—PLACENTA BIPARTITA.

**Multiple Placenta in Single Pregnancies.**—Occasionally in an ordinary single pregnancy the placenta is divided into several parts, which may be absolutely distinct, or more or less closely united. Such abnormalities have been studied more particularly by Hyrtl and Ribemont-Dessaignes, the latter stating that they occur about once in 352 cases.

In rare instances the placenta may be oblong in shape, with an aperture of varying size somewhere in the neighborhood of its center. To this abnormality Hyrtl applied the term *placenta fenestrata*. More frequently,



FIG. 484.—PLACENTA TRIPARTITA (Hyrtl).

the organ is more or less completely divided into two lobes. When the division is incomplete, and the vessels extend from one lobe to the other before uniting to form the umbilical cord, we speak of a *placenta dimidiata* or *bipartita*. According to Ahlfeld, this anomaly is noted about once in 600

cases. Again, the two lobes may be quite separate, the vessels being perfectly distinct and not uniting until just before entering the cord—*placenta duplex* (see Fig. 487). Occasionally the organ may be made up of three distinct lobes—*placenta triplex*; while in very rare instances it may



consist of a number of small lobes, Hyrtl having described as many as seven—*placenta septuplex*.

All of these conditions result from abnormalities in the blood supply of the decidua. Generally speaking, the portion of the ovum which is to

become converted into the chorion frondosum, and later into the fetal portion of the placenta, is that which is in contact with the most highly vascularized portion of the decidua. If the vascularization, instead of being practically limited to a single area, develops in several separate portions of the decidua, some such anomaly is bound to occur. Küstner believes that certain cases of *placenta bipartita* or *duplex* owe their



FIG. 485.—CORROSION PREPARATION OF PLACENTA SEPTUPLEX (Hyrtl).

origin to extensive infarct formation by which the intervening tissue is destroyed; but such an explanation cannot be accepted when the several lobules are separated from one another by apparently normal membranes.

**Placenta Membranacea.**—In rare instances the decidua reflexa is so abundantly supplied with blood that the chorion læve in contact with it fails to undergo atrophy. In such circumstances, the entire periphery of the ovum is covered by functioning villi, so that the placenta, instead of being a discoid organ limited to the decidua serotina, corresponds to the entire chorion—*placenta membranacea*. This abnormality does not interfere with the nutrition of the ovum, but occasionally gives rise to serious complications during the third stage of labor, since the thinned-out placenta is not readily separated from its area of attachment, and usually necessitates manual removal.

**Placenta Succenturiata.**—An important, and not infrequent, anomaly is the so-called *placenta succenturiata*, in which one or more small accessory



FIG. 486.—PLACENTA MEMBRANACEA (von Weiss).

lobules are developed in the membranes at some distance from the periphery of the main placenta. Ordinarily they are united to the latter by vascular connections. Occasionally, however, these are lacking, and as a result we have what are known as *placenta spuria*.

The placenta succenturiata is of considerable clinical importance, because the accessory lobules are sometimes retained in the uterus after the expulsion of the main placenta, and may give rise to serious hæmorrhage.

For this reason, one should always bear in mind the possibility of their existence, and, in examining the after-birth, the membranes should be inspected, as well as the placenta. Should small, roundish defects

be present a short distance from the placental margin, the retention of a succenturiate lobe should be suspected, and becomes a certainty if vessels extend from the placenta to the margins of the tear. If, in such cases, even slight hæmorrhage occurs, the hand should be introduced into the uterus for the purpose of locating and removing the offending structure.

#### Placenta Marginata.

—*Placenta marginata* will be considered later

in the chapter when we come to speak of infarcts of the placenta.

**Placenta Circumvallata.**—In exceptional instances, the foetal surface of

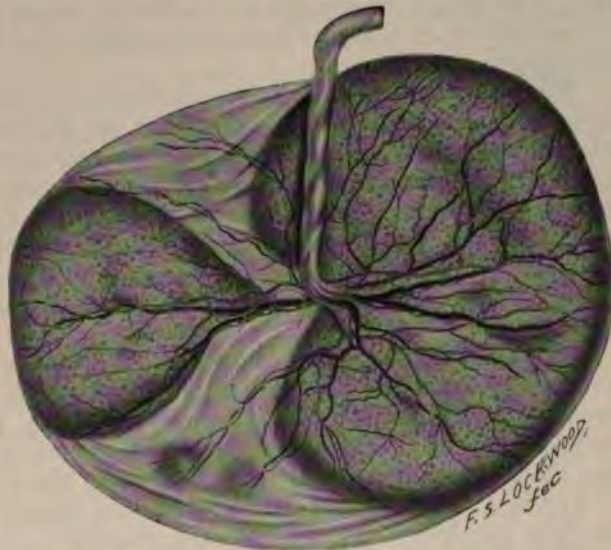


FIG. 487.—PLACENTA DUPLEX, WITH TWO SUCCENTURIATE LOBULES.  $\times \frac{1}{2}$ .



FIG. 488.—PLACENTA MARGINATA.  $\times \frac{1}{2}$ .



the placenta may present a central depression surrounded by an elevated portion, the amnion extending from the edges of the former. This condition is designated as *placenta circumvallata*, and is due to a proliferation of the villi at the margin of the placenta after the definite attachment of the amnion has occurred.

**Placenta Prævia.**—Once in several hundred cases the placenta, instead of being inserted upon the lateral wall or the fundus of the uterus, is implanted upon the lower uterine segment in such a manner as more or less completely to overlap the internal os—*placenta prævia*. As this condition is unavoidably associated with hæmorrhage during the first stage of labor, and is a most serious complication, it will be dealt with in a separate chapter.

### DISEASES OF THE PLACENTA

**Infarct Formation.**—The most frequent abnormality of the placenta consists in the development of certain degenerative changes, which have been variously designated as placentitis, schirrus, atrophy, hepatization, apoplexy, phthisis, fatty and fibro-fatty degeneration of the placenta, etc., but which are most appropriately described as *placental infarcts*.

These structures vary materially in size, shape, and appearance, and are best described under the following headings:

1. Small, whitish, or yellowish fibrous formations occurring upon either the foetal or maternal surface of the placenta, and varying in size from areas hardly visible to the naked eye to those having a diameter of several centimeters. These rarely attain a thickness of more than a few millimeters, and are sharply differentiated from the surrounding placental tissue.

2. Wedge-shaped or irregularly round areas, in the interior of the placenta. These are usually dull white in color, exhibit a striated, fibrous appearance, and present a striking contrast to the surrounding tissue, which appears to be perfectly normal.

3. Less commonly, considerable portions of the placenta are implicated in the process, and occasionally one or more cotyledons are converted into a pale white, dense, more or less fibrous tissue. In other instances a large portion of the organ may be involved in the change, one half and sometimes nearly its entire substance being implicated.

4. A broad rim of opaque, whitish, or yellowish-white material may extend for a varying distance around the margin of the foetal surface of the placenta, and occasionally forms a complete ring around it—*placenta marginata*. These bands vary from a few millimeters to several centimeters in breadth. They lie beneath the amnion and rarely attain a thickness of more than a few millimeters, except at the extreme margin of the placenta, where it merges into the membranes. In a certain number of cases the band, instead of being situated at the margin of the placenta, lies somewhere between it and the center of the organ, thus forming a broad zone more or less parallel to the periphery, but separated from it by apparently normal placental tissue. To this condition the term *margo placenta* is sometimes applied.

5. Pinkish or brickdust-colored, irregularly shaped, more or less solid



masses, sharply marked off from the surrounding tissue, may occupy a larger or smaller portion of the placenta. They are usually most prominent on the maternal surface, and frequently extend through its entire thickness; they are sometimes termed *red infarcts*.

Still more rarely, roundish areas varying from bright red to almost black in color, and measuring from one to three centimeters in diameter, are scattered through the substance of the placenta. They are composed almost entirely of blood, and are sharply differentiated from the surrounding tissue by a capsule which presents a more or less fibrous appearance. They may occur in considerable numbers, so that the entire placenta is studded with them and presents a nodular surface, and on section an appearance which Pinard has aptly described as *placenta truffé*.

These structures are also designated as red infarcts, though many authors prefer to speak of apoplexy or hæmatoma of the placenta. They differ markedly in structure and appearance from the other form of so-called red infarcts, and probably have nothing in common with them.

*Frequency.*—Minute white infarcts are to be found in every placenta, while similar areas, measuring 1 centimeter or more in diameter, were observed in 63 per cent. of 500 consecutive placenta which I examined. If not present in excessive numbers, they possess no clinical significance, and according to the researches of Eden and myself are to be regarded as signs of senility of the organ. On the other hand, when they are of large size and abundant, they may mechanically throw out of function so great a portion of the placenta as seriously to interfere with the nutrition of the foetus, and sometimes cause its death.

*Mode of Formation.*—According to the researches of Ackermann, Orth, Eden, Kermauner, and myself, infarct formation is the ultimate result of obliterating endarteritis in the vessels of the chorionic villi, and is brought about in the following manner: As soon as the circulation through the arteries of the chorionic villi is interfered with by the endarteritic process, necrotic changes begin to appear at their periphery (Plate XIV, Fig. 2). Owing to the fact that the syncytium is nourished in part by the maternal blood, the changes occur first in the layer of tissue just beneath it, and manifest themselves as coagulation necrosis of Langhans's layer of cells or the tissue which has replaced it. As the process becomes more marked, this is gradually converted into the so-called canalized fibrin. A little later the syncytium becomes implicated and undergoes a similar change, the fibrin then coming in direct contact with the maternal blood in the intervillous spaces. As a consequence, the blood immediately adjoining the necrotic tissue coagulates with eventual fibrin formation.

When necrotic changes occur simultaneously in several adjacent villi, the maternal blood lying between them undergoes coagulation, so that eventually a number of villi become fused together by fibrin. Still further changes then occur in the stroma of the incarcerated villi, the cells undergo coagulation necrosis, and finally the conversion into fibrin becomes so extensive that large areas are produced in which only the shadows of degenerated villi can be distinguished (Plate XIV, Fig. 1). Ultimately the outlines of the villi disappear, and the entire mass takes on a homoge-



neous fibrinous appearance, in which it is impossible to distinguish the component parts. For full particulars concerning the process, the reader is referred to my monograph upon the subject.

Steffeck and many recent writers are inclined to attribute the starting-point of the process to inflammatory and degenerative changes in the decidua. It would seem, however, that there are no grounds for such a belief, and that their conclusions were based upon faulty premises, in that these authors considered that the cells making up the so-called decidual septa were of maternal instead of foetal origin, as has been rendered probable by recent investigations.

Sfameni states that placenta marginata is noted in 15 or 20 per cent. of all after-births, and is inclined to attribute its origin to mechanical factors.

Red infarcts of the placenta are less frequently observed. They are sometimes associated with albuminuria on the part of the mother, which was present in 33, 60, and 67 per cent. of the cases collected by Cagny, Rossier, and Martin respectively. Unlike white infarcts, they possess a considerable clinical significance and, whenever well marked, are associated with imperfect development of the foetus, and sometimes cause its death. Unfortunately, we are not in a position to explain satisfactorily their mode

of formation, and must be content with pointing out the relation which they bear to albuminuria on the one hand, and to imperfect development of the child on the other.

Red infarcts are not, as a rule, observed in the placenta of eclamptic women, being noted only in those cases in which the onset of the disease has been preceded by distinct nephritic toxæmia.

#### Cysts of the Placenta.—Cystic struc-

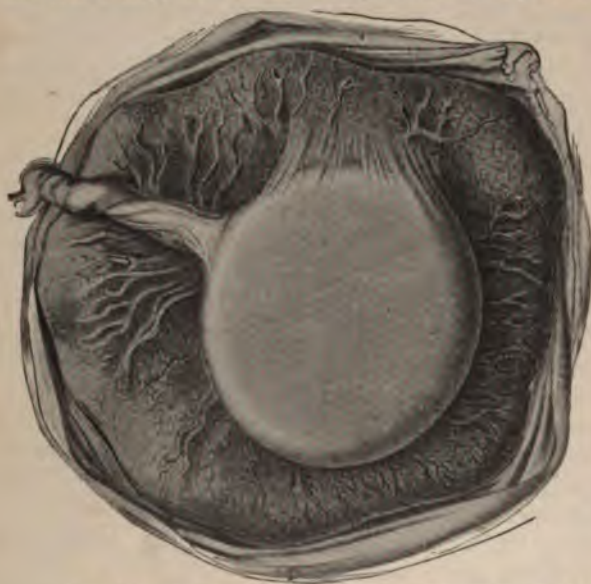
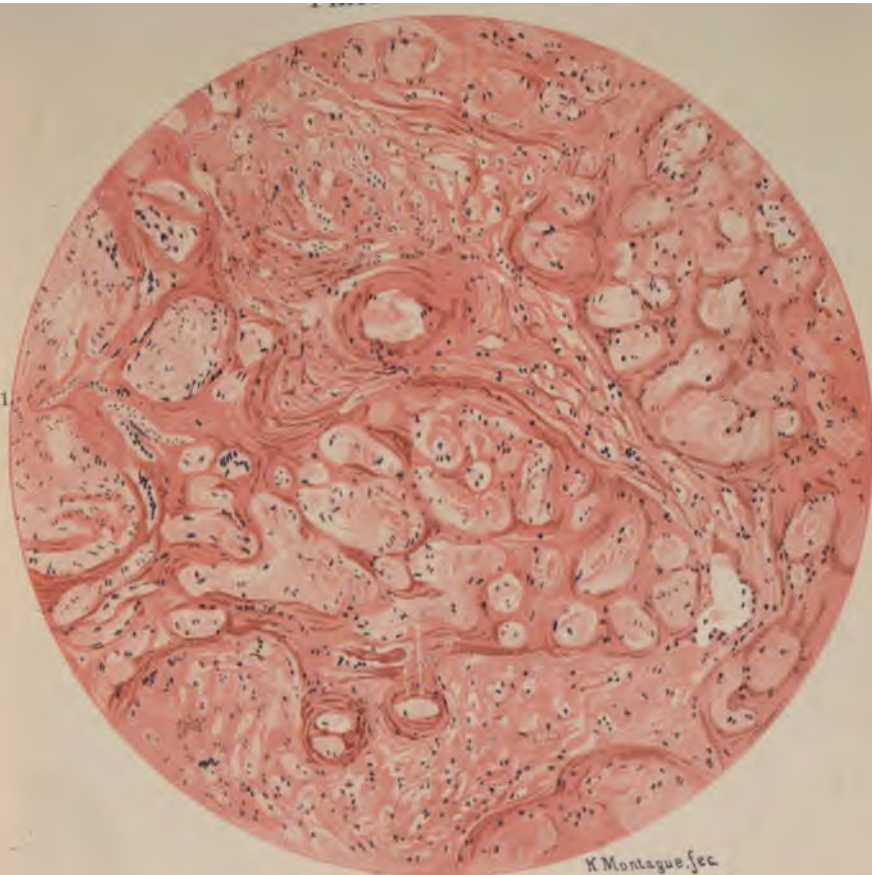


FIG. 489.—CYST OF PLACENTA (Ehrendorfer).  $\times \frac{1}{2}$ .

tures are frequently observed upon the foetal surface and occasionally in the depths of the placenta. Small cysts a few millimeters in diameter were noted in 56 per cent. of the placenta studied by Kermauner. Larger ones, occasionally attaining the size of a lemon, are observed but rarely.

Cysts projecting from the foetal surface of the placenta are derived from the chorionic membrane, as is shown by the fact that the amnion

Fig. 1



K Montague, fec

Fig. 2



K. M. Montague

INFARCT FORMATION.  $\times 60$ .

FIG. 1.—Fully developed infarct.  
FIG. 2.—Chorionic villi, showing endarteritis and formation of canalized fibrin. B., blood in intervillous spaces; C. F., canalized fibrin; End., arteries showing obliterating endarteritis.





can be readily stripped off from them. Their contents are usually clear and transparent, but are sometimes bloody or grumous in character. The walls, especially the portions adjacent to the intervillous spaces, are lined in great part by a dull whitish membrane, while occasionally a portion is occupied by a white infarct.

On microscopic examination, the lining membrane is found to be made up mainly of one or more layers of tolerably large epithelial cells with round vesicular nuclei, which frequently present various degrees of degeneration. Here and there, corresponding to the situation of a white infarct, the cells are absent and the wall consists of fibrin. The researches of Ehrendorfer, Peiser, De Jong, Vassmer, and Schickele have clearly shown that the cells in question correspond to those of Langhans's layer, and that the cysts result from the degeneration of masses of trophoblastic tissue.

The cysts occurring in the depths of the placenta rarely exceed 1 centimeter in diameter. They frequently occupy the center of an infarct, are filled with grumous contents, and were mistaken by the older writers for abscesses. In other cases the contents are clear. Such structures may be derived in one of two ways: either by the softening and breaking down of an infarct, the cyst-wall then consisting of fibrin, or more frequently from the degeneration of the trophoblastic cells which make up most of the so-called "decidual septa." In the latter case the walls are composed of cells identical with those observed in the cysts occurring upon the foetal surface of the placenta.

So far as present experience goes, cystic formations, whether occurring upon the foetal surface or in the depths of the placenta, are of interest purely from a pathological point of view, and exert little or no influence upon the course of pregnancy or labor.

**Tumors of the Placenta.**—John Clarke in 1798 described a solid tumor about the size of a man's fist, which made up a large part of the placenta. Since then a number of tumors, varying in size from that of a pea to that of a man's fist, have been described, particularly in recent years. Dienst and Schindler in 1903 and 1908, respectively, were able to collect 48 and 79 cases from the literature.

According to Virchow, the most frequent variety of placental tumor is the myxoma fibrosum, which is composed in great part of fibrous tissue having abundant oval nuclei, with typical myxomatous areas scattered through it. Until recently the placental tumors have been variously designated, and the 36 examples collected by Albert were classified as follows:

|                                     |    |
|-------------------------------------|----|
| Myxoma fibrosum .....               | 14 |
| Fibroma .....                       | 10 |
| Angioma .....                       | 9  |
| Sarcoma .....                       | 2  |
| Hyperplasia of chorionic villi..... | 1  |

The researches of Dienst, Pitha, and Schindler, however, show that they are practically all of one type, and consist of masses of chorionic villi with immense hypertrophy and hyperplasia of the terminal vessels, so



that they may be designated as chorio-angiomata. Dienst suggested that they be designated as chorioma angiomatosum, or fibrosum, according as dilated vessels or connective tissue predominate. In many instances the tumor is connected with the chorion by a small pedicle, in which an artery and vein can usually be distinguished, and Pitha holds that the ætiological factor is to be sought in interference with the circulation in these vessels.

As the chorio-angiomata do not affect the surrounding placental tissue, they do no harm unless they involve so considerable an area as to throw a large part of the placenta out of function. Albert, on the other hand, holds that they exert a deleterious influence upon the course of pregnancy and labor.

Walz in 1906 described a number of multiple tumors in the placenta presenting a structure typical of myxosarcoma. These he considered were metastases from a similar tumor in the leg, which originated during pregnancy. If his interpretation is correct, the observation represents a unique pathological condition.

The only placental tumor which I have seen was a lobulated structure, about the size of a hen's egg, which occupied the maternal surface of the organ. Histologically it was a sarcoma.

**Inflammation of the Placenta.**—Under the term *placentitis* many of the older writers described changes which we now recognize as infarct formation. Moreover, as has already been said, small placental cysts filled with grumous contents were formerly thought to be abscesses. Hence it follows that most of the statements in the abundant early literature upon inflammatory lesions of the placenta must be received with the greatest caution. At the same time acute inflammation of the placenta is occasionally met with. It is not a primary condition, but is due to the extension of a similar process from the decidua, the latter resulting from an exacerbation of a preëxisting chronic gonorrhœa, or from an acute infection due to the gonococcus or other pyogenic bacteria. Very exceptionally, abscess formation may be a manifestation of a general infection originating in any portion of the body.

Frequently, upon examining sections of placental tissue under the microscope, I have found the decidua serotina infiltrated with leukocytes and presenting the characteristic picture of an acute inflammation, while the adjacent intervillous spaces were crowded with leukocytes. Franqué observed similar conditions, but is inclined to believe that in most instances the implication of the placenta is secondary to the death of the fœtus.

**Tuberculosis of the Placenta.**—Tubercle formation in the fœtal portion of the placenta is extremely infrequent. For particulars the reader is referred to the chapters upon the Physiology of the Fœtus and upon the Infectious Diseases Complicating Pregnancy.

**Calcification of the Placenta.**—Small calcareous nodules, sometimes occurring in the form of flat plaques, are frequently observed upon the maternal surface of the placenta, and are occasionally so abundant as to cause it to resemble a piece of coarse sand-paper. Fränkel showed that the chalky material was usually deposited in the necrotic tissue surround-

ing the ends of the "fastening" villi, as well as in the superficial layers of the decidua serotina.

When the almost universal occurrence of degenerative changes in the placenta is remembered, it should be a matter of surprise, not that calcification is occasionally met with, but rather that it is not noted in almost every placenta, inasmuch as apparently ideal conditions for its formation are constantly present in the later months of pregnancy.

**Abnormal Adherence of the Placenta.**—In the vast majority of cases the term *adherent* placenta is a misnomer, since the interference with its expulsion is usually due to abnormalities in the uterine contractions rather than to abnormal adhesions between it and the uterine wall. In rare instances, on the other hand, the adhesions may be so firm and extensive that spontaneous separation becomes impossible, and occasionally cannot be effected even at autopsy except by tearing either the placenta or the uterine wall.

Neumann and Hense have recently examined uteri in which this condition obtained. Microscopic examination showed that the decidua serotina was almost entirely absent, and that the chorionic villi were in direct contact with the uterine muscle and the connective tissue separating its fibers. Under such circumstances the absence of the spongy layer of the decidua readily explains the clinical phenomena.

#### ABNORMALITIES OF THE UMBILICAL CORD

**Variations in Insertion.**—The umbilical cord is usually inserted eccentrically upon the foetal surface of the placenta, somewhere between its center and periphery. A central insertion is less common, while in a still smaller number of cases the junction has taken place near the margin, giving rise to a condition known as *battledore placenta*.

In a series of 2,000 placenta, which I studied in this regard, the insertion was eccentric in 73.25 per cent., central in 18.25 per cent., and marginal in 7.25 per cent. These variations possess no clinical significance.

On the other hand, the so-called *velamentous insertion of the cord*—*insertio velamentosa*—is of considerable practical importance. In this condition the vessels of the cord separate some distance from the placental margin and make their

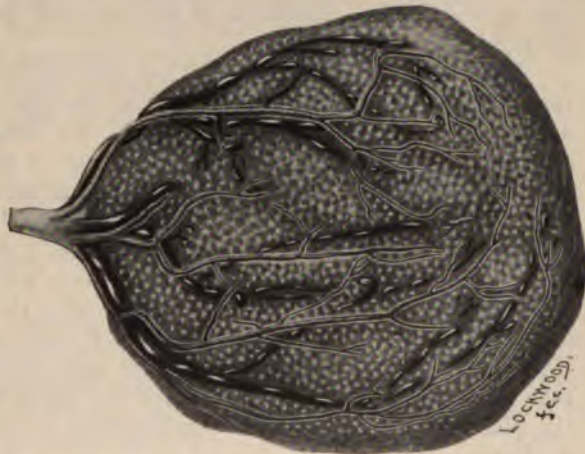


FIG. 490.—MARGINAL INSERTION OF THE CORD. BATTLEDORE PLACENTA.



way to the latter in a fold of amnion (Fig. 327). This mode of insertion was noted in 0.84 per cent. of 15,894 placentæ examined by Lefèvre, and in 1.25 per cent. of our cases. According to Mironoff it occurs nine times more frequently in twin than in single pregnancies, being noted in 5 and 0.57 per cent. of the cases respectively.

Its mode of production has given rise to a great deal of speculation. So long as the old views were in vogue concerning the part played by the allantois and the amnion in the formation of the umbilical cord, Schultze's explanation obtained almost universal acceptance. According to this, the anomaly was the result of abnormal adhesions between the umbilical vesicle and the chorionic membrane, whereby the amnion was prevented from applying itself in the usual manner to the cord. At present, however, this explanation is not regarded as satisfactory, as the researches of His clearly show that the allantois plays an insignificant part in the formation of the cord in human beings.

Franqué in 1900 advanced the following theory as to the mode of origin of the velamentous insertion. In the vast majority of cases the abdominal pedicle extends from that portion of the chorion which is in contact with the most richly vascularized portion of the decidua—ordinarily the decidua serotina—so that the cord becomes inserted upon the placenta. Occasionally, however, during the first few days of pregnancy, the area of greatest vascularization may be in the decidua reflexa, and the abdominal pedicle then takes its origin from the portion of chorion in contact with it. With the advance of pregnancy, however, the area of vascularization shifts to the decidua serotina—the site of the future placenta—while the abdominal pedicle retains its original position, and from its maternal end the vessels extend to the placental margin. Peters, while recognizing the fallacy of Schultze's explanation, is not prepared to accept that proposed by Franqué.

When the placenta is inserted low down in the uterus, the velamentous vessels may extend partially across the internal os—*vasa prævia*—and as dilatation progresses be pressed upon by the presenting part, the interference with the circulation causing asphyxia of the foetus. In rare cases such vessels are torn through when the membranes rupture, and the foetus bleeds to death. The full literature upon this subject up to 1898 has been collected by Peiser, while Knapp has reported a case in which the accident led to the death of both twins developed from a single ovum.

**Variations in Length of Cord.**—Normally, the umbilical cord averages about 55 centimeters in length, though it may present marked variations—3.5 to 198 centimeters (Dyhrenfurth and Hyrtl). In rare instances it may be so short that the abdomen of the foetus is almost in contact with the placenta, but under such circumstances a congenital umbilical hernia is always present.

According to Kaltenbach the cord must be of a certain length in order to permit of delivery of the child—that is, it must be sufficiently long to reach from its placental insertion to the vulva, 35 centimeters when the placenta is inserted high up, and 20 centimeters when low down. As a matter of fact it rarely measures less than 25 centimeters.

On the other hand, it sometimes happens that cords, which actually exceed the normal in length, may be so twisted about the child as to become practically too short. Accordingly, one distinguishes between absolute and accidental or relative shortness of the cord. Either of these conditions may give rise to serious dystocia. Brickner, who has carefully studied the subject, states that delivery cannot occur under such circumstances unless one of the following accidents occur: separation of the placenta, inversion of the uterus, umbilical hernia of the foetus, or rupture of the cord, the last two being of infrequent occurrence.

**Rupture of the cord** may result from absolute or accidental shortness, being due to the former in Dyhrenfurth's, and to the latter in Ahlfeld's case, in which the cord measured 44 centimeters in length, but was tightly twisted about the foetus. Ordinarily an excessively long cord exerts no deleterious influence, although it predisposes to the formation of loops during pregnancy and to prolapse at the time of labor.

**Knots of the Cord.**—It is customary to distinguish between false and true knots, the former being due to developmental abnormalities in the cord, while the latter result from the active movements of the child. True knots occur very frequently, and occasionally are of the most complicated character. Ordinarily they are of no clinical importance, but occasionally they may be pulled so taut as to compress the vessels and lead to asphyxia of the foetus.

**Loops of the Cord.**—The cord frequently becomes wrapped around portions of the foetus, and in every third or fourth case of labor the child's neck will be found loosely encircled by one or more loops. In rare instances these may produce strangulation. Most of these accidents are not due to any drawing taut of the loop, but rather to the fact that it does not become looser in proportion as the neck of the child increases in size. In other cases loops of the cord may so tightly encircle the body or one of the extremities of the child as to give rise to deep depressions, which in extreme cases may eventuate in the strangulation or gangrene of the affected part.

In single-ovum twins in which the amniotic partition wall has been broken through it not infrequently happens that the cord of one foetus may become wrapped around some portion of the other so tightly as to cause its death. A number of cases of this character have been collected by Hermann.

**Torsion of the Cord.**—As the result of movements on the part of the foetus, the cord may become more or less twisted. Occasionally the torsion is so marked as to interfere seriously with the circulation. The most extreme degrees are observed only after the death of the foetus, Schauta having reported a case in which 380 twists were noted. In rare instances separation of the cord is produced, though this is possible only after the death of the foetus in the early months of pregnancy.

**Inflammation of the Cord.**—As long as the child is alive inflammatory conditions are rarely noted, but after its death the Whartonian jelly is found to be infiltrated with leukocytes. Particularly in syphilis, obliterative changes occur in the vessels, the lumina becoming almost completely



occluded, although it is observed in other conditions; and, as has already been pointed out, is believed to be an occasional factor in the production of hydramnios.

**Varices of the Cord.**—In rare instances *varices of the cord* may rupture as the result of undue pressure. Meier has reported a case in which the death of the foetus was attributable to such an accident.

**Tumors of the Cord.**—Tumor formations implicating the cord are rarely seen. Hæmatomata occasionally result from the rupture of a varix with subsequent effusion of blood into the cord. In one instance I observed such a tumor, 5 centimeters in diameter, at the foetal end of the cord. Myxomata and myxosarcomata have also been described. Winckel has reported two cases of sarcoma of the cord, while Budin has described an apparently typical dermoid.

Cystic structures occasionally occur in the course of the cord, and are designated as true and false cysts respectively, according to their mode of origin. The former are always quite small and, according to Kleinwächter, may be derived from remnants of the umbilical stalk or of the allantois; while the latter may attain a considerable size and result from liquefaction of the Whartonian jelly. Haas has described a case of the latter variety and collected the literature upon the subject up to 1906. As a rule they are only apparent, and result from the liquefaction of the myxomatous tissue of the cord.

**Edema of the Cord.**—This condition is rarely noted by itself, but is frequently associated with oedematous conditions of the foetus. It is very common in dead and macerated children. In one of my cases, in which the child was born alive at full term, the cord was 3 centimeters in diameter and resembled an eel in appearance. Microscopic examination showed that the condition was simply due to an increase in the amount of Whartonian jelly.

## DISEASES OF THE FŒTUS

**Fœtal Syphilis.**—Syphilis is the most frequent cause of foetal death in the later months of pregnancy, and may be maternal, or possibly paternal, in origin. The mother may be suffering from the disease at the time of conception, or may contract it during the course of pregnancy. In the first case, it is believed that transmission to the foetus occurs through the ovum, whereas in the other it takes place through the placenta. As a rule, the latter mode of infection is possible only when the mother is inoculated during the early months of pregnancy, though exceptions are occasionally noted. Contrary to the present trend of opinion, as was stated in Chapter XXV, I am inclined to believe that in certain instances the disease is paternal in origin, and is transmitted in some way by the spermatozoa. In such cases the mother will or will not contract the disease according as the father does or does not present infectious lesions at the time of coitus. Since these are usually absent, the mother escapes, while the foetus ordinarily becomes inoculated—*Colles' law*. The fact that, in the majority of such cases, the mother presents a positive Wassermann reaction does not,

to my mind, necessarily indicate that she is suffering from latent syphilis. At present we know too little of the significance of this reaction to be dogmatic, but I consider it quite within the range of possibility that, in the future, it may be demonstrated that it may be due to the transmission of anti-bodies through the placenta, quite as well as to the presence of living spirochætae in the mother.

It has long been known that a syphilitic infection exerts a most deleterious influence upon the product of conception. Usually it leads to the premature expulsion of a macerated foetus. Less commonly the child is born alive showing distinct manifestations of the disease, while in other cases they do not appear until a later period.

It is of the greatest importance that the practitioner should become thoroughly familiar with the characteristic lesions of foetal and placental syphilis, as upon their recognition the future treatment of the patient often depends. This is a point especially worthy of emphasis, inasmuch as, in consequence of ignorance or design on the part of one or both parents, the first intimation that the physician has of the existence of the disease is often afforded by the birth of a dead child, or the appearance of syphilitic stigmata in a living one.

Syphilis not only gives rise to characteristic lesions in the foetus, but also affects the placenta, so that frequently a diagnosis can be made from an examination of the latter organ. This fact is of special importance in those cases in which the foetus is born alive, or when an autopsy is not permitted upon a dead child. The appearance of the syphilitic foetus varies materially according as it is born alive or dead. In either instance it is markedly undersized, and the subcutaneous fat is poorly developed or entirely lacking. In the living child the skin presents a dry, drawn appearance, and has a peculiar grayish hue. It is very brittle, especially at the flexor surfaces of the joints, where abrasions readily occur and expose the underlying corium. The skin covering the soles of the feet and palms of the hands is often thickened and glistening, and suggests the condition observed in the hands of washerwomen. In other cases, characteristic pemphigoid vesicles are noted upon the palms of the hands and soles of the feet.

If intra-uterine death has occurred, the foetus rapidly undergoes maceration, the skin peeling off upon the slightest touch and exposing the underlying discolored corium. Although Gräfenburg states that 80 per cent. of macerated children are syphilitic, the condition is by no means pathognomonic, since it occurs whenever a dead foetus is long retained *in utero*, no matter what the cause of death.

The lesions in the internal organs consist essentially in interstitial changes in the lungs, liver, spleen, and pancreas, and osteochondritis in the long bones.

It is generally stated that the lungs frequently contain gummatous nodules. These, however, were lacking in the specimens which I have examined. Usually the lungs are enlarged, pale, and scarcely float when thrown into water. On microscopic examination the alveoli are found filled with cast-off epithelial cells in all stages of fatty degeneration—



catarrhal pneumonia, the *pneumonia alba* of Virchow. In other cases the lesion consists in an increase in the interstitial tissue associated with pronounced round-cell infiltration, by which the alveoli are compressed, but do not become quite impervious to air. These changes have been exhaustively studied by Heller.

As the result of hypertrophic cirrhosis, the liver undergoes a marked increase in size, and, according to Ruge, its weight may equal one tenth or even one eighth of that of the whole body, instead of one thirtieth, as usual. Under the microscope there is a marked increase in the connective tissue surrounding the individual lobules and acini, with here and there small areas of round-cell infiltration.

The spleen likewise undergoes interstitial changes and increases markedly in size, so that it frequently weighs two or three times as much as



Fig. 491.



Fig. 492.

FIGS. 491, 492.—NORMAL AND SYPHILITIC FETAL EPIPHYSIS.  $\times 2$ .

usual which, roughly speaking, is one three-hundredths of the body weight. The pancreas also presents interstitial changes, and is slightly larger than normal.

Prior to the sixth month, Tissier and Girauld state that the *spirochaeta pallida* is rarely found, but after that period the foetus may be said to suffer from a spirochaetal septicæmia, when the parasites may be demonstrated in large numbers in the various organs and blood. They are most abundant in the adrenals, occurring in 97.5 per cent. of all cases, according to Trinchese, and progressively less so in the following organs: liver, pancreas, liver, and internal genitalia.

The recognition of these lesions requires some little pathological experience, though if the liver and spleen are found markedly increased in size the diagnosis of syphilis is permissible.

Another characteristic sign, and one which is readily detected, is the changes occurring at the junction of the epiphysis with the

diaphysis in the long bones—Wegner's bone disease. Normally the two are separated by a narrow, whitish, slightly curved line, 0.5 to 1 millimeter in diameter—Guérin's line—representing the zone of preliminary calcification, which constitutes the scaffolding upon which the new bone is developed. In syphilis, on the other hand, this becomes converted into an irregular, jagged, yellowish zone 2, 3, or more millimeters in thickness. In advanced cases this alteration is associated with considerable softening and the formation of a soft pultaceous material, which occasionally leads to complete separation of the epiphysis (Figs. 491 and 492).

Upon microscopical examination of the normal epiphysis, as shown in Fig. 493, the cartilage cells are found to be arranged in parallel columns at right angles to Guérin's line, while below it is the typical bony structure of the diaphysis with its marrow cavities. The line itself is formed by a deposit of lime salts between the median ends of the rows of cartilage cells, and is gradually invaded by the newly formed bone.

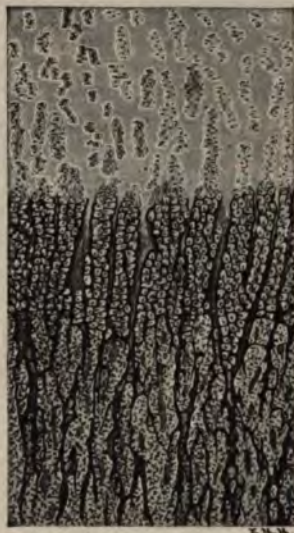


FIG. 493.—NORMAL FETAL EPIPHYSIS.  $\times 60$ .

In syphilis, as illustrated in Fig. 494, the changes are due to an *osteochondritis*, as the result of which there is no longer a sharply marked zone of preliminary calcification between the cartilage and the growing bone; but areas of bone formation, calcification, and leukocytic and small-

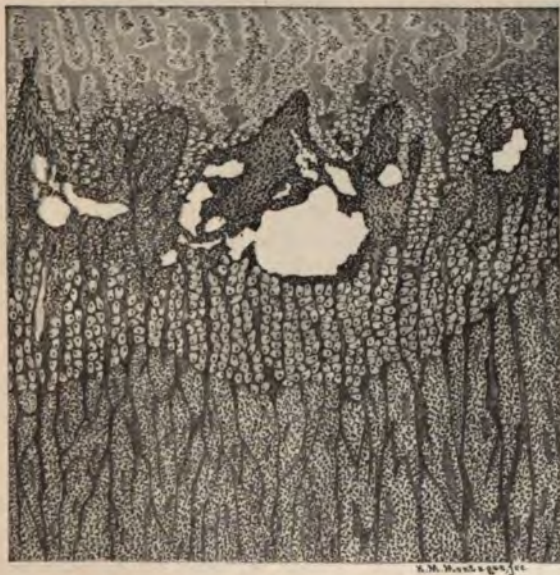


FIG. 494.—SYPHILITIC FETAL EPIPHYSIS.  $\times 60$ .

cell infiltration are found scattered irregularly through the lower portion of the epiphysis, giving an irregular appearance to this region.

These changes, which have been carefully studied by Wegner and R. Müller, are most readily recognizable at the lower end of the femur, and fairly well at the lower ends of the tibia and radius. They are less clearly defined at the upper ends of the tibia, fibula, and femur, and only in rare instances can they be



made out at the ends of the ribs. They are extremely characteristic, and their detection justifies one in making a positive diagnosis and placing the mother under specific treatment.

**Placental Syphilis.**—Under the influence of syphilitic infection the placenta undergoes very characteristic changes. It becomes larger and paler in color, and, if the foetus is dead, often presents a dull, greasy appearance. It is always relatively, and frequently absolutely, increased in size, and, according to the researches of Correa-Dias and Schwab, which I have been able to confirm, instead of one sixth it may represent as much as one fourth, or even a larger fraction, of the entire body weight of the foetus.

Still more characteristic, however, are the changes in the chorionic villi,



FIG. 495.

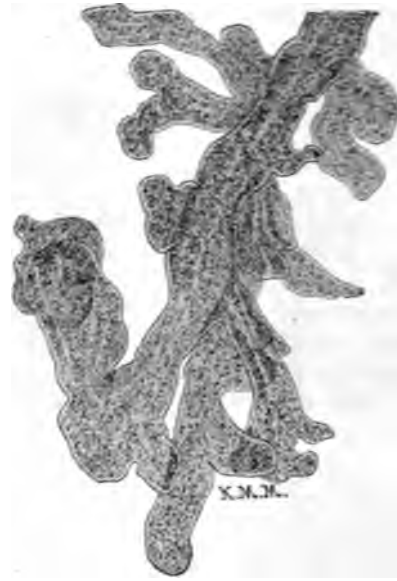


FIG. 496.

FIGS. 495, 496.—NORMAL AND SYPHILITIC CHORIONIC VILLI TEASED OUT IN SALT SOLUTION, SLIGHTLY MAGNIFIED.

to which Fränkel called attention in 1873. In syphilis the villi, when teased out in salt solution, are seen to have lost their characteristic arborescent appearance and to have become thicker and more club-shaped (Figs. 495 and 496). At the same time there is a marked decrease in the number of blood-vessels, which disappear almost entirely in advanced cases. This results partly from endarteritic changes, but principally from a proliferation of the stroma cells, which lose their normal stellate appearance, becoming round or oval in shape, and closely packed together.

Similar changes are observed in sections made from hardened specimens. As will be seen on comparing Figs. 497 and 498, the individual villi are markedly increased in size and almost devoid of blood-vessels, while their stroma is made up of closely packed, round, or oval cells. This appearance is so characteristic as to enable one with a little practice to make

a probable diagnosis, and at the same time affords a satisfactory explanation for the poor development of the foetus.

The work of Nelis, Thomsen, Mohn, and others tends to show that the changes just described, while very suggestive, are not absolutely characteristic; and the latter holds that a positive diagnosis cannot be made unless the presence of the spirochæta *pallida* of Schaudinn is demonstrated. This has been done by many investigators; although they are so sparsely scattered through the organ that their recognition is most difficult, even when they are present in large numbers in the foetal organs. Trinchese states that they can always be found, if one is willing to study several hundred sections, but in my clinic Pauli and Emmons were not so successful.

In my experience a positive Wassermann can always be obtained when the placental lesions are typical, but, on the other hand, it may be present when histological changes are too slight to permit a positive diagnosis.

It is generally stated that distinct syphilitic lesions, varying from a marked thickening of the membrane to distinct gumma formation, are frequently noted in the decidua. I am inclined to be-



FIG. 497.—NORMAL FULL-TERM PLACENTA.  $\times 50$ .

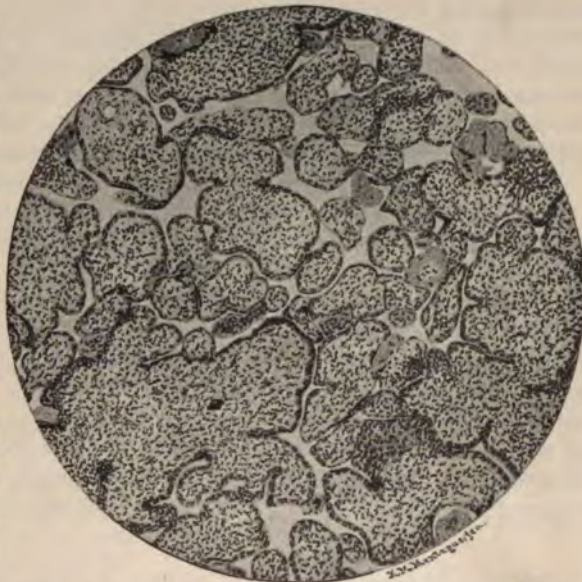


FIG. 498.—SYPHILITIC FULL-TERM PLACENTA.  $\times 50$ .



lieve, however, that many of the conditions described as such have no connection with lues, but represent various hyperplastic conditions.

Zilles, and many of the earlier writers, described gummata occurring in the foetal portion of the placenta. I have never met with such lesions, and am of the opinion that careful histological study will show that the structures designated as such are merely infarcts in various stages of development or degeneration.

Bondi in 1903 directed attention to changes in the umbilical cord, which he considered very characteristic, and his findings have been confirmed by most subsequent writers. These occur in the vessels, and consist in oedema of their walls, and leukocytic infiltration of the spaces between the muscle fibers. Similar changes are noted in the adventitia, while the intima is more or less thickened. Mohn stated that he was able to demonstrate the presence of the spirochæta in 50 per cent. of his cases, but subsequent study has shown that he was in error. They are sometimes present in the foetal end, but only rarely in the rest of the cord. Trinchese in 100 cases found them in 18 instances in the former, but never in the latter location, and Emmons in my clinic had a similar experience.

**General Dropsy of the Fœtus.**—In this rare condition, 65 instances of which have been collected by Ballantyne, the fœtus and placenta are markedly oedematous. As the result of infiltration with serum the former may attain immense proportions and the latter be increased to three or four times its normal size. In a case under my observation the fœtus, at the seventh month of pregnancy, weighed 1,140 and the placenta 1,200 grams. Cohn has described a placenta weighing 2,900 grams.

Although a good deal has been written upon the subject, no satisfactory explanation of the anomaly has as yet been arrived at. Formerly it was supposed to result from oedematous conditions of the mother, but the researches of Ballantyne have shown that this view does not always hold good, and that in the majority of the cases submitted to a thorough study lesions were noted in the organs of the fœtus sufficient to explain the production of the condition. It is interesting to note that in several cases collected by Seifert it was attributed to foetal leukæmia.

The disease always leads to the death of the fœtus, which in no instance survived its birth for more than a few hours. In the majority of cases on record labor was spontaneous, though occasionally the increased size of the fœtus and the placenta may give rise to dystocia.

**Other Diseases of the Fœtus.**—In most text-books upon obstetrics numerous morbid conditions of the fœtus are described under the heading Diseases of the Fœtus. The majority of them, however, are of interest mainly from a pathological point of view, and have no obstetrical significance, except in those cases in which they lead to an increase in the bulk of the fœtus, which in turn may give rise to difficult labor. Accordingly, they will not be considered in this place, though certain of them will be referred to in the chapter upon Foetal Dystocia.

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## CHAPTER XXIX

### ABORTION, MISCARRIAGE, AND PREMATURE LABOR

Spontaneous expulsion of the ovum may occur at any period of pregnancy, and is variously designated according to the degree of development which the product of conception has attained. Thus, it is customary to speak of abortion, of miscarriage, or of premature labor, respectively, according as the pregnancy terminates before the sixteenth week, between the sixteenth and twenty-eighth week, or at a later period.

Prior to the sixteenth week, owing to the imperfect development of the placenta, the entire ovum often comes away intact. From that time on, however, the placenta forms a definite organ and the expulsion of an intact ovum is exceptional, the fœtus, as a rule, being extruded first, and followed after a longer or shorter period by the placenta and membranes. After the twenty-eighth week the course of labor differs but little from that observed at full term, and the child, if properly cared for, may survive; its chances of so doing increasing in almost geometrical proportion with every additional week.

As the term *abortion* is somewhat suggestive of a criminal procedure, it is rarely employed in popular parlance, all cases terminating prior to the period of viability being designated as miscarriages. Among medical men, on the other hand, the latter term is but little used, and it is customary to speak of all cases ending before the twenty-eighth week as abortions.

**Frequency.**—It is difficult to arrive at accurate conclusions concerning the frequency with which spontaneous abortion occurs. Inasmuch as only such women as are more or less seriously ill enter lying-in hospitals, the statistics based upon their records would give too low an estimate—in my service about 6 per cent. of all patients. On the other hand, sufficiently large series from private practice are not available; though Malins found that 19.23 per cent. of the pregnancies of 2,000 patients ended in abortion. Franz states that abortion occurred in 15.4 per cent. of the cases admitted to the lying-in hospital at Halle, the accident being more than twice as frequent in multiparæ as in primiparæ. A conservative estimate would indicate that about every fifth or sixth pregnancy in private practice ends in abortion, and the percentage would be increased considerably were the very early cases taken into account, in which there is profuse loss of blood following the retardation of the menstrual period for a few weeks. Tausig estimates that one abortion occurs to every 2.3 labors, and considers that considerably over one quarter of all abortions are criminally induced. It is difficult to give accurate figures in this regard, but it is generally



admitted that the practice is becoming more and more frequent in all strata of society throughout the civilized world.

**Ætiology.**—In the early months of pregnancy spontaneous expulsion of the ovum is nearly always preceded by the death of the foetus. For this reason, the consideration of the ætiology of abortion practically resolves itself into determining the cause of foetal death. In the later months, on the other hand, the foetus is frequently born alive, and other factors must be invoked to explain its expulsion. Foetal death may be due to abnormalities occurring in the ovum itself, or to some disease on the part of the mother, and now and again of the father.

(a) One of the most usual causes for the death of the foetus is to be found in abnormalities of development, which are inconsistent with life. The investigations of Mall indicate that such conditions are present in one-third of all early abortions, and would have resulted in monstrosities had pregnancy continued. In another group of cases it results from changes in the foetal appendages, such as excessive torsion of the cord, hydramnios or hydatidiform mole. In the last named affection the nutritive material conveyed to the intervillous spaces by the maternal blood merely suffices to nourish the hypertrophic villi, little or none remaining to be transmitted to the child.

Particularly in the later months of pregnancy, syphilis and certain diseases and abnormalities of the placenta may lead to the same result. Thus, Merittens and Franqué have described an obliterating endarteritis in the vessels of the chorionic villi, independent of syphilis, which interferes with the foetal circulation to such an extent as to be incompatible with life. In other cases, the abundant formation of red or white infarcts may throw so large a portion of the placenta out of function that the remainder is not sufficient to supply the needs of the foetus. Such abnormalities as placenta prævia, low implantation of the placenta, or velamentous insertion of the cord, as well as premature separation of the placenta, may likewise bring about circulatory conditions inconsistent with foetal life.

Diseases of the heart and kidneys may likewise play a prominent part in the causation of foetal death. In the former it is attributed to imperfect aeration of the blood; in the latter it may result directly from the accumulation of excrementitious substances in the maternal blood and their subsequent transmission to the foetus; or, indirectly, from the fact that large portions of the placenta are thrown out of function by extensive infarct formation. Less commonly diseases of the liver or lungs of the mother may be indirectly responsible.

(b) As was pointed out in the chapter upon the Accidental Complications of Pregnancy, all acute infectious diseases have a tendency to bring about the death of the child and its subsequent expulsion from the uterus. The fatal result is usually due to the transmission of toxins, and occasionally of the specific micro-organisms from the mother to the child. Poisoning with phosphorus, lead, illuminating gas, and other substances may lead to similar results.

Foetal death is sometimes attributable to malnutrition on the part of



the mother, although this is very exceptional. On the other hand, it is not unusual for women suffering from wasting diseases to give birth to fully developed children.

(c) Generally speaking, abnormalities in the generative tract play a most important part in the ætiology of abortion. Thus, developmental anomalies of the uterus, or imperfect development of the normally formed organ, may be responsible for conditions which are unfavorable for the implantation of the ovum and later for the development of the placental circulation. Chronic metritis is also supposed to act in the same way. Dense adhesions about the tubes and ovaries, resulting from inflammatory processes, only rarely interfere with the expansion of the uterus sufficiently to give rise to abortion, since in most cases the bands of adhesions gradually stretch and become elongated.

Displacements of the uterus, more particularly retroflexion and prolapse, are justly considered as very important factors in the causation of abortion. As a rule, the interruption of pregnancy is due less to the abnormal position of the uterus than to lesions of its endometrium resulting from circulatory changes incident to the displacement. In the rare cases of incarceration, however, the accident must be attributed to the persistent abnormal position of the organ.

The most important condition of the generative tract leading to the production of abortion is afforded by diseases and abnormalities of the decidua. In the hypertrophic forms of decidual endometritis—decidua polyposa—the bulk of the maternal blood brought to the placental site goes to nourish the hyperplastic decidua, while in the atrophic forms the conditions are unfavorable for the implantation of the ovum and the development of the placenta. More important still is the part played by chronic glandular endometritis and acute inflammation of the decidua. These conditions are frequently accompanied by hæmorrhagic changes, and are the most frequent cause of abortion in the early months. Histological examination demonstrated the presence of acute or chronic decidual endometritis in 70 per cent. of my specimens, but in many instances it was impossible to determine whether it was the primary cause, or merely an accidental complication. The presence of myomata in the walls of the uterus must be looked upon as an occasional factor, abortion resulting less from the mechanical effect of the tumor itself than from the changes in the decidua incident to it.

McFayden and Bang have directed attention to epidemics of abortion occurring in cattle, and have shown that they are due to a specific micro-organism, which leads to the interruption of pregnancy when inoculated into the genitalia of healthy animals. H. L. Russell has shown that similar conditions obtain in this country, and holds that the economic loss connected with it is exceeded only by the ravages due to tuberculosis. Apparently, such infections do not occur in women, and although bacteria are frequently present, they are simply the well-known pyogenic or putrefactive varieties.

In a few cases the cause of abortion is to be sought for in reflex influences, which take their origin from lesions of the generative tract or from



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**Ætiology.**—In the early months of pregnancy spontaneous expulsion of the ovum is nearly always preceded by the death of the fœtus. For this reason, the consideration of the ætiology of abortion practically resolves itself into determining the cause of fœtal death. In the later months, on the other hand, the fœtus is frequently born alive, and other factors must be invoked to explain its expulsion. Fœtal death may be due to abnormalities occurring in the ovum itself, or to some disease on the part of the mother, and now and again of the father.

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In a few cases the cause of abortion is to be sought for in reflex influences, which take their origin from lesions of the generative tract or from



irritative conditions about the breasts. In very rare instances the accident is attributable to intense mental emotions—anger, fright, or grief.

It is customary to distinguish between *predisposing* and *exciting causes* of abortion. The various factors to which allusion has just been made predispose to abortion, while the exciting cause is often of a mechanical nature, such as a slight fall, jar, or overexertion. The statements of the patient concerning the latter, however, must be received with caution, as in many cases they are merely incidental and have no connection with the interruption of pregnancy. At the same time, it must be admitted that the apparently healthy uterus sometimes possesses an abnormal degree of irritability, and will react to stimuli which ordinarily would be without effect. In such women the slightest violence, such as coitus, a misstep, tripping over a carpet, or a ride over a rough road, may bring on an abortion; while in others the most violent exercise and the rudest manipulations may be borne with impunity. Occasionally a simple bimanual examination may be followed by an abortion; while, on the other hand, every physician can recall cases in which a sound has been introduced into the pregnant uterus without ill effects, and in rare instances, in the later months, the repeated introduction of a large bougie, or even of a Champetier de Ribes balloon, will fail to bring about satisfactory uterine contractions.



FIG. 499.—EARLY ABORTION, SHOWING DECIDUA REFLEXA AND SEROTINA WITH DEGENERATE EMBRYO.  $\times 1$ .

(d) Practically the only paternal cause of abortion is syphilis, which, as has already been said, frequently leads to the changes in the placenta and the organs of the fœtus, which bring about its death and premature expulsion from the uterus.

To sum up, the most important ætiological factors in the interruption of pregnancy in the first four months are endometritis, uterine displacements, and abnormalities in development, while after this period syphilis and Bright's disease play a similar rôle. Thus, Sentex, in 485 cases of intra-uterine death occurring in the later months of pregnancy in Pinard's clinic, found the underlying cause to be syphilis in 42.7, albuminuria in 19.8, and diseases and abnormalities of the fœtus in 11.1 per cent.

It is not unusual to meet with women who give a history of repeated abortion or premature labor occurring at about the same time in a number of successive pregnancies. If the interruption has occurred in the first half of pregnancy, careful examination will usually demonstrate the existence of an endometritis or a uterine displacement; and it is only after the cure of the underlying condition that subsequent pregnancies can be expected to progress to full term. When repeated premature labor has occurred in the second half of gestation, signs of albuminuria, Bright's disease, or syphilis will usually be discovered, though occasionally no satisfactory explanation can be adduced.

**Pathology.**—In the first half of pregnancy, the immediate cause of the expulsion of the ovum is to be found in hæmorrhagic changes in the decidua. Concerning their mode of production we must confess a profound ignorance, although when endometritis is the underlying cause their origin is readily understood. These changes, which are most marked in the decidua serotina, are followed by degeneration of the affected tissues, as the result of which the attachment of the ovum becomes more or less loosened, and the product of conception comes to act as a foreign body, and gives rise to uterine contractions, which, after a longer or shorter period, lead to its expulsion.



FIG. 500.—TUBEROUS SUBCHORIAL HEMATOMA (Breus).  $\times 1$ .

Especially in the early months, the entire ovum may be expelled after a few premonitory symptoms, and frequently the entire decidual lining of the uterine cavity is cast off at the same time. In such cases a triangular sac comes away which represents the decidua vera, which contains in its interior the rounded vesicular ovum, covered by the decidua reflexa. More frequently, however, the decidua vera remains *in utero*, while the ovum, surrounded by the decidua reflexa, is expelled. Occasionally the reflexa is torn through, and, together with the decidua vera and serotina, is retained *in utero*, while a shaggy, more or less spherical structure is cast off—the ovum surrounded by the chorionic villi.



As pregnancy advances, the expulsion of the entire ovum is observed less frequently, so that after the fourth month it is the rule for the membranes to rupture and the fœtus to be expelled by itself, to be followed, or not, by the placenta and membranes. Occasionally the entire ovum may be expelled even at a later period, and I have seen several cases in which this occurred as late as the seventh or eighth month. This, however, is very unusual, the course of premature labor being identical with that observed at full term.

In many early abortions, the expelled ovum is a thin-walled cystic structure, filled with clear fluid and containing a minute degenerated embryo, or only a remnant of the umbilical cord. This condition represents an early stage of hydramnios, and corresponds to the dropsical or blighted ovum of the early writers.

In many instances, the process of abortion occurs very slowly, so that the blood poured out between the periphery of the ovum and the decidua has an opportunity to coagulate. Under such conditions, the ovum on its expulsion is surrounded by a capsule of clotted blood of varying thickness with degenerated chorionic villi scattered through it. In its interior is a small cavity filled with clear fluid and lined by a thin, glistening membrane (the amnion), from one point of which hangs the umbilical cord and the partially degenerated fœtus. Such structures are classified as *blood* or *carneous moles*, according to their appearance. In the former the capsule of coagulated blood is red in color, while in the latter it presents a paler appearance, the result of fibrin formation (Fig. 501).

Now and then, the interior of such structures, instead of being lined by the smooth amnion, may present an irregular nodular appearance, which is due to the formation of hæmatomata of varying size beneath the amnion and chorion. This condition, to which Granville applied the term *ovum tuberculosum*, has been more particularly studied by Breus, who designated it as *tuberous subchorial hæmatoma* of the decidua (Fig. 500); while Berry Hart, and Taussig described the condition as hæmatoma mole, or tuberous fleshy mole, respectively. Breus believed that the tuberous appearance was the result of hæmorrhage into collapsed folds of the amnion, while Gottschalk, Walther, Hart, and others considered that the hæmorrhage was the primary factor. Davidsohn and Taussig take the view that the disproportion between the size of the fœtus and the ovum is the result of hydramnios, and after the death of



FIG. 501.—SECTION THROUGH BLOOD MOLE.  $\times 1$ .

the former the amniotic fluid is gradually absorbed, when the redundant amnion becomes folded upon itself, the blood being effused into its folds.



In all uterine moles the foetus is relatively smaller in size than would naturally correspond with the menstrual history. This fact indicates that the process is of gradual formation, and that a considerable period has elapsed between the death of the foetus and the expulsion of the ovum. Not uncommonly, indeed, the foetus may undergo complete dissolution, or be represented merely by a stub of umbilical cord hanging from the interior of the ovum; while in rare instances all trace of it may disappear, and, after resorption of the amniotic fluid, the ovum may be represented by a solid mass of varying size, composed of chorionic villi embedded in coagulated blood.

*Dissolution* of the dead foetus is possible only in the early weeks of pregnancy, and cannot occur after it has attained any considerable proportions. In the latter class of cases the retained foetus may undergo *maceration*. In such circumstances, the bones of the skull collapse, the abdomen becomes distended with a blood-stained fluid, and the entire foetus takes on a dull reddish color due to staining with blood pigment. At the same time the skin softens and peels off at the slightest touch, leaving behind the bright-red corium. The internal organs degenerate, and become soft and friable, losing their capacity for taking up the usual histological stains. In rarer instances the foetus becomes compressed and takes on a dry, parchment-like appearance—*mummification*. This is rarely observed in ordinary abortion, but is noted with comparative frequency in twin pregnancies, when one foetus has died at an early period while the other has gone on to full development—*foetus papyraceus*.

In very exceptional instances, the foetus may be retained *in utero* for a long period, until the deposition of lime salts upon it converts it into what is known as a *lithopædion*. This phenomenon, though extremely rare in uterine pregnancy in human beings, is relatively common in the lower animals. In extra-uterine gestation, on the other hand, it is not of unusual occurrence.

**Clinical History.**—From a clinical standpoint, it is a matter of considerable importance to distinguish the period at which the pregnancy is terminated. When it occurs in the first half it is not unusual for the ovum to be expelled as a whole, while in the second half of pregnancy the course of events is similar to that observed at a full-term labor.

The onset of abortion is usually preceded by certain premonitory symptoms, the most important of which are hæmorrhage and pain in the back and lower abdomen. Loss of blood, no matter how slight, in the early months of pregnancy, should always be regarded with suspicion, for, if it be not a premonitory symptom of abortion, it usually indicates the existence of a decidual endometritis, or an abnormal implantation of the placenta. When due to the former, the discharge is usually not very profuse, and is of a dirty brown or brownish-red color, while when due to the latter it is apt to be more profuse and distinctly bloody in character. The premonitory bleeding may persist for weeks, or be promptly followed by the expulsion of the ovum. Indeed, in some cases the latter event may occur so rapidly as to surprise the patient.

When a patient in the first few weeks of pregnancy begins to lose blood,



and the flow is associated with pain in the lower abdomen and back, an abortion is *threatened*. It, however, does not become *imminent* unless the hæmorrhage be profuse or the cervix considerably dilated; even in the latter event it is not impossible for the disturbance to subside, and for pregnancy to go on without interruption. On the other hand, rupture of the membranes and escape of the liquor amnii indicate that abortion is *inevitable*.

When abortion becomes imminent, the hæmorrhage is usually quite profuse, though as a rule not sufficient to endanger the life of the woman. At the same time she experiences severe cramp-like pains in the abdomen due to the uterine contractions, which later become distinctly bearing-down in character. After the cervix has become sufficiently dilated, the detached ovum may be expelled intact from the uterus, and when not retained in the vagina comes away spontaneously. This is known as *complete abortion*.

More frequently, on the other hand, after rupture of the membranes and the escape of the amniotic fluid, the fœtus alone is expelled, while the placenta and membranes remain in the uterus—*incomplete abortion*. In such cases the hæmorrhage usually persists until the retained structures are extruded spontaneously or are removed artificially, though the pains usually cease with the expulsion of the fœtus. After the uterus has rid itself of the product of conception, the hæmorrhage and pain cease, and a process of involution begins, identical with that observed after full-term labor. In my experience spontaneous abortion occurs most frequently during the second and third months of pregnancy, and the relative incidence of the complete to the incomplete variety is in the ratio of one to three.

✓ **Treatment.**—Prophylactic treatment is most important, although, as a rule, it is not available in women aborting for the first time. If, however, the patient presents a history of repeated abortion or premature labor, precautionary measures should be instituted before conception has again taken place.

The general and local condition should be carefully investigated and any abnormality subjected to appropriate treatment. If the patient has a retroflexed uterus, the organ should be replaced and held in position by a properly fitting pessary. If the desired results are not obtained in this way, the uterus should be suspended by a suitable operation. If endometritis be present, the patient should be curetted and warned against becoming pregnant until sufficient time has elapsed to allow the uterus to recover from the morbid condition. If the symptoms reappear, the operation should be repeated. If there is no abnormality in the generative tract, the possibility of syphilis in either parent should be borne in mind. The Wassermann reaction should be tested, and appropriate treatment instituted if it proves positive. The urine should always be carefully examined with a view to determining the presence or absence of renal lesions.

If past experience has shown that the patient has an irritable uterus and is predisposed to abort upon the slightest provocation, coitus should be interdicted during pregnancy, and the patient be cautioned against over-exertion, particularly upon the days during which the menstrual period would ordinarily occur, and be encouraged to lead a careful, well-ordered



existence. Occasionally, the only efficient means of leading the process to a successful termination is by keeping the patient in bed throughout pregnancy.

*Treatment of Threatened Abortion.*—Whenever symptoms of threatened abortion appear, the patient should be placed in bed and kept in a recumbent position. If pains occur, a hypodermic injection of  $\frac{1}{4}$  grain of morphine should be administered at once, to be followed by 1-grain rectal suppositories of extract of opium, repeated at intervals of every four or six hours. Better results are occasionally obtained by combining the opium with the extracts of hyoscyamus and viburnum prunifolium. The following suppository, administered every four or six hours, according to circumstances, often gives most satisfactory results:

|                              |         |
|------------------------------|---------|
| R. Codinæ sulphat. ....      | gr. ss. |
| Ext. hyoscyami .....         | gr. j.  |
| Ext. viburni prunifolii..... | gr. v.  |
| Ol. theobromæ .....          | q. s.   |

In many instances the symptoms rapidly subside under such treatment, but the patient should be kept in bed for at least a week after their disappearance, in the hope of avoiding any repetition.

In other cases, the pain yields to the administration of sedatives, but the hæmorrhage persists, and we then have to decide how long we are justified in permitting the bloody uterine discharge to continue, and whether there is any probability that the pregnancy will progress normally.

So long as the loss of blood does not exceed that usually observed at the menstrual period, the flow is not necessarily incompatible with the continuance of pregnancy, and may be permitted to go on for some time. In view of the part played by developmental abnormalities of the fœtus in the production of abortion, it is my opinion that palliative treatment is frequently continued unnecessarily long. Consequently, if the symptoms do not disappear after a few weeks, I allow the patient to assume her usual avocations, in the hope that the threatened abortion will become inevitable. On the other hand, if the bleeding becomes so profuse that the patient begins to show signs of anæmia, the uterus should be emptied by the methods to be described later. In many instances, notwithstanding appropriate treatment and rest in bed, slight hæmorrhage may persist for weeks, and it then becomes necessary to ascertain whether there is any possibility of the pregnancy continuing. Unfortunately, this problem usually requires several weeks for its solution. Thus, if bimanual examination shows at the end of two weeks that the uterus has remained stationary in size, one is justified in concluding that the fœtus has perished; while, on the other hand, an increase probably indicates that the fœtus is still alive, but does not necessarily mean that pregnancy will go on to a happy termination. As soon as we are convinced that the fœtus is dead, the uterus should be emptied. In such cases nothing can be gained by delay, as abortion will inevitably occur sooner or later, whereas temporizing treatment sometimes exposes the patient to serious danger.



*Treatment of Inevitable Abortion.*—When convinced that abortion is inevitable, particularly in those cases in which the hæmorrhage is profuse, the uterus should be emptied in the most conservative manner, the choice of procedure depending upon the degree of dilatation of the cervix. If it be sufficiently patulous to admit a finger, the patient should be anæsthetized, brought to the edge of the bed, and prepared for operation. The carefully sterilized hand, anointed with sterile vaseline, having been introduced into the vagina, one or preferably two fingers are carried up into the uterine cavity, and, under the guidance of the other hand applied over the abdomen, peel off the ovum from the uterine wall and slowly extract it. If this cannot be effected, the ovum should be broken up by the finger, and the fragments extracted by means of a placental or ovum forceps, under the guidance of a finger within the uterus.

But if, as often happens, the cervix is not sufficiently dilated to permit the introduction of a finger, the cervical canal and vagina should be packed tightly with a narrow sterile gauze bandage, as described in Chapter XXIV. When removed at the end of twenty-four hours, the pack frequently brings with it the intact ovum; but, even if this does not occur, the cervix will generally be sufficiently dilated to permit the introduction of the finger, when the ovum can be removed as recommended above. The introduction into the cervical canal of a laminaria tent is recommended by many authorities. While it affords a satisfactory method of dilatation, I strongly deprecate its employment, as I know no way by which it may be rendered absolutely sterile.

Except when the hæmorrhage is so profuse as seriously to threaten the patient's life, these methods of procedure are preferable to the rapid dilatation of the cervix with a Goodell or some similar dilator, followed by the immediate removal of the ovum by means of a curette or polypus forceps. Moreover, the cervix is sometimes so resistant that it is impossible to dilate it sufficiently to permit the introduction of the finger, the employment of which, in my opinion, is essential for the proper evacuation of the uterus and the careful exploration of its cavity after removal of the ovum.

No doubt the uterus can be satisfactorily evacuated in most cases by means of the curette and polypus forceps, but no instrument has ever been invented which will prove an efficient substitute for the carefully trained sense of touch when it becomes necessary to satisfy one's self that no remnants of the ovum are still retained in the uterus. On several occasions I have seen patients profoundly exsanguinated from profuse hæmorrhage following the supposed thorough removal of the product of conception by curettage, but, on introducing the finger into the uterus, I have found that it still contained the bulk of the ovum. Experiences of this kind have therefore led me to do away with the use of instruments except in very rare cases. Moreover, in addition to the fact that they fulfill their object only imperfectly, they are not devoid of danger. Every gynæcologist is familiar with cases in which the softened uterus has been perforated by the curette, and knows of rare instances in which a loop of gut has prolapsed through the opening so made. With these experiences in mind, it has become more and more my practice to resort to vaginal hysterotomy whenever prompt



evacuation of the uterus becomes necessary in the presence of a rigid cervix, the only contra-indication being the existence of infection.

When the ovum has been expelled intact, as in complete abortion, there is no necessity for further interference; and, as a rule, if the decidua vera is not cast off, it is not advisable to attempt its removal by means of the curette, as it is usually expelled spontaneously within a few days. At the same time, the physician should always satisfy himself by careful inspection that the entire ovum has come away, and that portions of it are not retained. In incomplete abortion, on the other hand, the retained placenta and membranes should be removed manually by the methods already described, since as soon as the uterus is emptied it contracts and the danger of hæmorrhage has passed.

It often happens that the physician does not see the patient until some days after the expulsion of the fœtus, when he is summoned on account of the persistent loss of blood. In such cases the cervix is usually found to be retracted to such a degree that it will not admit the finger, but it can readily be sufficiently dilated by means of a Goodell dilator to permit the introduction of a finger, after which the remnants of the ovum are removed.

In many cases of criminally induced, or neglected, abortion infection may occur. Symptoms may develop while the entire ovum is still in the uterus, in the course of an incomplete abortion, or after the completion of the entire process. The latter will be considered in the chapter upon puerperal infection. The two former conditions are always serious, and are responsible for the greater part of the deaths following abortion. The infection may be due to the streptococcus or to the various so-called putrefactive bacteria, and in hospital practice it is advisable to take an intra-uterine culture before undertaking any manipulation. The prognosis is always serious when the former bacteria are concerned, but very favorable when they are absent. In either event, the uterus should be promptly emptied in the most conservative manner, and afterward washed out with an abundance of sterile salt solution. The complication of a rigid cervix is always a source of anxiety, as the existence of infection contraindicates the employment of vaginal hysterotomy, and renders more serious the lacerations which are usually associated with instrumental dilatation; whereas in cases of infected incomplete abortion the uterus can usually be emptied without difficulty. Fortunately, in the great majority of cases, the temperature promptly falls after evacuating the uterus, and the patient goes on to complete recovery. In my streptococcus cases, however, the mortality was 28 per cent., and, in view of a similar experience, Winter has raised the question as to whether it would not be better in such cases to defer interference until the acute symptoms have subsided.

With the exception of infected cases, the prognosis following abortion is excellent, provided a rigid technique is scrupulously observed. I have never had a death in an uninfected patient, and Young and Williams in a series of 1,331 such cases, with an operative incidence of 87 per cent., record a mortality of only 0.07 per cent.

The treatment of abortion in the second half of pregnancy and of pre-



mature labor is identical with that already described for full-term labor, and does not require further mention.

**Missed Abortion.**—This term was applied by Oldham to the cases in which the foetus is retained in the uterine cavity for months or years after its death. The condition occurs frequently in mares, cows, and sheep, but comparatively rarely in women. Seventy cases were collected from the literature by Graefe in 1896, and 105 by E. Fraenkel in 1903, though I am convinced from my own experience that such figures give a very inadequate idea of the frequency of the condition.

Retention may exist for a long period without giving rise to symptoms, and such a possibility should always be borne in mind in the case of an abortion occurring in a woman who has been for some time separated from her husband, inasmuch as an error in this regard occasionally results in irreparable damage to her character. In other cases the patient may believe herself to be in the seventh or eighth month of pregnancy, and yet on examination the uterus will be found to correspond in size to that of a much less advanced period. More frequently, however, the patient may present signs of threatened abortion, but, after a varying period, the loss of blood and the pain disappear under appropriate treatment, so that there is apparently every prospect that the pregnancy will go to term. Some months later the physician will be consulted on account of the failure of the abdomen to enlarge, or the occurrence of regressive changes in the breast, when upon examination the uterus will be found to be smaller than it was at the time of the threatened abortion. Not uncommonly the condition, after persisting for some time without symptoms, may exert an appreciable effect upon the patient, who may suddenly begin to lose flesh, suffer from a foul taste in her mouth, perhaps present a slight elevation of temperature, and occasionally symptoms of mental derangement.

According to Veit and Graefe, the retention is to be attributed to a lack of irritability on the part of the uterus, which does not contract as usual under the stimulation exerted by the dead ovum acting as a foreign body. In quite a number of cases the foetus has been retained for more than one year, and in one instance for twenty-eight years. After expulsion the ovum frequently presents the characteristic structure of a hæmatoma mole; in other cases there are no manifestations of hæmorrhage, and one has to deal with a so-called "dropsical ovum." In one of my cases, which had persisted for more than one year, the foetus was mummified, the amniotic fluid almost entirely resorbed, and the placenta transformed into an infarct-like mass.

Whenever the diagnosis is established beyond doubt, the cervix should be dilated by means of a vaginal and cervical pack, and the uterus emptied of its contents. In several instances under my observation the cervix was so resistant that its dilatation by means of steel instruments was out of the question.

In very exceptional instances the entire product of conception may be absorbed without a sign of external discharge. Polano and L. Fraenkel have reported cases in which this occurred after the pregnancy had advanced as far as the fourth month, and Koebner has demonstrated its possibility by animal experiments.

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## CHAPTER XXX

### EXTRA-UTERINE PREGNANCY

IN *extra-uterine pregnancy* the fertilized ovum is arrested at some point between the ovary and the uterus, and there undergoes more or less complete development. *Ectopic gestation*, which is sometimes used as a synonymous term, has a broader meaning, inasmuch as it includes not only the usual forms of extra-uterine pregnancy, but also those in which the ovum is implanted in the rudimentary horn of a bicornuate uterus. Reference has already been made to this class of cases in Chapter XXVII.

For a long time extra-uterine pregnancy was of interest chiefly from a pathological point of view, but since 1883, when Tait first operated upon a case of ruptured tubal pregnancy, the subject has attained a markedly practical interest, as is manifested by the immense literature of recent years. The history of its development is treated in detail in the monographs of Campbell, Hecker, Parry, Tait, Werth, and Webster.

Prior to 1876, extra-uterine pregnancy was considered so rare an affection that Hennig stated that even the directors of large obstetrical institutions might never encounter a case, and Parry was able to collect only 500 instances from the entire literature. It was only with the gradual development of abdominal surgery that its relative frequency became recognized. Thus, Schrenck, in 1892, collected 610 cases which had been reported in the preceding five years, but since then many operators have placed on record large series of cases, and it is now generally admitted that extra-uterine pregnancy is encountered in several per cent. of all gynecological laparotomies.

**Classification.**—As the fertilized ovum may be arrested at any point on its way from the Graafian follicle to the uterine cavity, it may undergo development in the ovary or in any portion of the tube, giving rise to ovarian or tubal pregnancy respectively. It is extremely doubtful whether the ovum can become implanted upon the peritoneum and a primary abdominal pregnancy follow.

**Ætiology.**—According to Leopold, ovarian pregnancy results from the fertilization of the ovum before its escape from the Graafian follicle. Moreover, he believed, when several follicles mature at the same time, that a deeply lying one may rupture into a more superficial one without the escape of its ovum, in which event the latter may be fertilized by spermatozoa entering through the superficial follicle. Such an occurrence would afford a satisfactory explanation for a pregnancy occupying the central portion of

the ovary, and the fact that several investigators, following the example of Tussenbroek, have demonstrated corpus luteum cells about the periphery of the ovum would also speak in its favor.

Unfortunately, equally concise and definite statements cannot be made concerning the ætiology of tubal pregnancy, although a number of explanations, of greater or less plausibility, have been advanced. Broadly speaking, these may be divided into three main groups: (1) Conditions which interfere mechanically with the downward passage of the ovum; (2) Inflammatory diseases of the tubes; (3) Physical and developmental abnormalities which favor decidual formation in the tubes.

*I. Conditions Which Interfere Mechanically with the Downward Passage of the Ovum.*—(a) Fritze, in 1779, first directed attention to the fact that peritoneal adhesions, by compressing the lumen of the tube or by interfering with its peristalsis, might cause the arrest of the ovum.

(b) Leopold, Breslau, Beck, Wyder, and others believed that polypi projecting into the lumen of the tube might occasionally interfere with the descent of the ovum. It is quite possible, however, that such structures were merely decidual outgrowths, and had appeared only after conception.

(c) Some observers believe that myomata, or other tumors, situated in the wall of the tube or in adjacent organs, may so compress the tubal lumen as to interfere with the passage of the ovum.

(d) Schroeder, in 1887, but more particularly Tait, a few years later, advanced the theory that the most frequent ætiological factor was an endosalpingitis. This they supposed led to the destruction of the cilia and the consequent cessation of the downward current, thereby allowing spermatozoa to enter the tube.

This view presupposed that fertilization occurred in the uterine cavity, and was based upon the belief that the ciliary current was directed downward in the tubes and from below upward in the uterus, the entry of spermatozoa into the uterine cavity being thereby facilitated, while their access to the tubes was rendered difficult. The work of Hofmeier and Mandl has demonstrated the fallacy of these suppositions. Moreover, it is now generally held that fertilization occurs normally in the tubes, so that the problem to be solved in every case of tubal pregnancy is not how the spermatozoa may have gained access to the tubes, but why the fertilized ovum failed to make its way to the uterus.

Furthermore, the cilia may persist in spite of acute inflammation, and I have been able to demonstrate their presence in nearly every pregnant tube which I have examined, while Zedel saw them in motion in several specimens which he examined in the fresh condition.

(e) Abel, Kreisch, and others believe that the fœtal convolutions of the tube occasionally persist in later life, and hinder the downward passage of the fertilized ovum either by constricting the lumen or by interfering with peristalsis.

(f) In 1891 Landau and Rheinstein, and I demonstrated the presence of *diverticula* from the lumen of the tube, and suggested that a fertilized ovum entering such a structure would eventually be arrested at its blind end, where it might undergo further development (Fig. 502). Specimens, in



which the foetal sac lay entirely outside of the lumen of the tube, being separated from it by a layer of tissue of varying thickness (see Fig. 508), apparently offered confirmatory evidence of such an occurrence. After further examination of my specimens, however, while not wishing to deny



FIG. 502.—DIVERTICULUM FROM THE LUMEN OF TUBE.

such a possibility, I am of the opinion that such conditions can usually be more satisfactorily explained by supposing that the fertilized ovum had burrowed beneath the mucosa of the tube, just as it does into the decidua in uterine pregnancy.

Now and again, in serial sections through the tube, it is possible to



FIG. 503.—PREGNANCY IN ACCESSORY TUBAL OSTIUM (Henrotin and Herzog).

A, small accessory ostium; B, opening of pregnant ostium; C, blind end of same; D, blood-clot containing remnants of ovum.

demonstrate the presence of accessory lumina—long processes, which extend from the main lumen and, after continuing parallel to it for a considerable distance, rejoin it, or end blindly. In several instances, I have noted condi-

tions which seemed to indicate that the fertilized ovum had been arrested in such a structure.

Sometimes accessory ostia, instead of communicating with the lumen of the tube, represent mere *culs-de-sac*. That the fertilized ovum may be arrested in such a structure and go on to further development was conclusively demonstrated by Henrotin, Herzog, and Walthard (Fig. 503).

(g) Dührssen believes that in occasional instances the arrest of the ovum may be due to puerperal atrophy of the tube, whereby its normal peristalsis is markedly impaired. Hoehne attributes a similar result to general hypoplasia.

(h) In a considerable number of cases which I have examined, the corpus luteum was situated not in the ovary corresponding to the pregnant tube, but in the opposite one, indicating that *external migration* had occurred, and that the fertilized ovum had made the transit of the pelvic cavity. Sippel believes that such a phenomenon may favor the production of extra-uterine pregnancy, since the fertilized ovum may attain such proportions during its migration as to prevent its passage through the tube.

## II. *Conditions Resulting from Inflammatory Conditions of the Tubes.*

—As has already been said, Schroeder and Tait pointed out the ætiological importance of such conditions. This view is supported by the fact that many cases of tubal pregnancy have been preceded by pelvic inflammatory trouble. Thus Dührssen, Mandl and Schmidt, Küstner, Petersen, Runge, and others were able to elicit a history of gonorrhœal salpingitis or of inflammatory lesions of the appendages in more than two-thirds of their cases. After it had been demonstrated that the arrest of the ovum was not due to the destruction of the cilia by the inflammatory process, great difficulty was experienced in explaining the connection between the two conditions. In 1902 Opitz found definite histological inflammatory lesions in two-thirds of his specimens, and, even when they were absent, noted that the tips of many of the folds of the mucosa had become fused together, so that the section presented the cribriform appearance characteristic of the so-called "follicular salpingitis." As similar lesions were usually present in the non-pregnant tube, he held that they afforded a very satisfactory explanation for the arrest of the ovum. He assumed that some of the canals inclosed between the adherent folds communicated freely with the main lumen of the tube, but ended blindly at the other extremity, so that if a fertilized ovum were arrested in such a *cul-de-sac* a tubal pregnancy would develop.

After similar observations had been made by Micholitsch and others, this explanation was enthusiastically accepted by Werth, who considered it of almost universal application. I have frequently observed the same condition, and have no doubt that it may be a frequent ætiological factor.

## III. *Physical and Developmental Conditions Which Favor Decidual Formation in the Tubes.*

—Webster believes that the explanation for the comparatively infrequent occurrence of tubal pregnancy is to be found in the fact that the decidual reaction, which he considers essential to the proper implantation of the fertilized ovum, is usually lacking. He holds that tubal pregnancy can come about only when the tubes are capable of this reaction,



which he considers represents a reversion to an earlier type, and may be regarded as a sign of degeneracy. This view was indorsed by Pantellani, Mandl and Schmidt, Wormser, Moericke, and others, but the belief is based upon theoretical considerations rather than upon anatomical observation.

From what has just been said, it is apparent that there is no lack of theories concerning the ætiology of tubal pregnancy, and the question which we have to consider is which of them is correct, or whether any one is of universal application.

Theoretically, it would appear that certain of the mechanical conditions mentioned above must frequently play a part in the production of the affection. On the other hand, it must be admitted that diverticula from the lumen of the tube, and the so-called follicular salpingitis, are frequently noted, while tubal pregnancy occurs but comparatively rarely.

Tainturier, and Mandl and Schmidt applied ligatures to various portions of the generative tract of rabbits shortly after copulation. When applied to one uterine cornu some distance below the tubal opening, ova developed distal to the ligature, as well as in the normal horn, and when both cornua were ligated no ova developed median to the ligatures. On the other hand, when the ligatures were applied to the uterine ends of the tubes, extra-uterine pregnancy did not develop, although dead ova could be demonstrated in the tubes above the ligatures. In a series of control experiments, when only one tube was ligated, the same result was obtained on that side, while the other horn contained normal embryos.

These experiments show conclusively that in the rabbit, at least, some factor other than mere mechanical interference with the downward passage of the ovum is necessary to the production of tubal pregnancy, and this Mandl and Schmidt sought in a preliminary decidual reaction. The fact, however, that the recent work upon the anatomy of the pregnant tube shows that the decidual formation is never abundant, and is frequently altogether absent, would militate strongly against such a view.

The only positive experimental work along these lines was reported by Nuck many years ago, but it is probably open to the objection that he did not distinguish carefully enough between the uterine cornua and the tubes in the lower animals.

The idea that the affection is a sign of degeneration or reversion, while extremely interesting, and to a certain extent borne out by facts, cannot be accepted as a universal solution of the problem; for in many instances the condition occurs in perfectly healthy women who live amid the best surroundings. Moreover, its great rarity in the lower animals also speaks against such a view. Bland Sutton states that in his large experience in the zoölogical gardens of London he has never met with tubal pregnancy in animals, and believes that all such cases recorded in the literature are due to confounding the uterine cornua with the tubes. This statement, however, is somewhat too radical, as Waldeyer has reported an undoubted case in an ape.

In view of the considerations just adduced, it is apparent that the ætiology of tubal pregnancy is not a simple matter, and that there is no universal cause for all cases. In many instances, the arrest of the

ovum in a crypt resulting from follicular salpingitis, or in a diverticulum, may afford a satisfactory explanation. On the other hand, in a certain proportion of cases even the most careful clinical history and microscopical examination of the specimen will fail to reveal a tangible cause for the condition, which will then remain as great a problem to us as to our predecessors.

**Ovarian pregnancy** was first described in the seventeenth century, by Mercerus and St. Meurice, after which it was generally recognized until

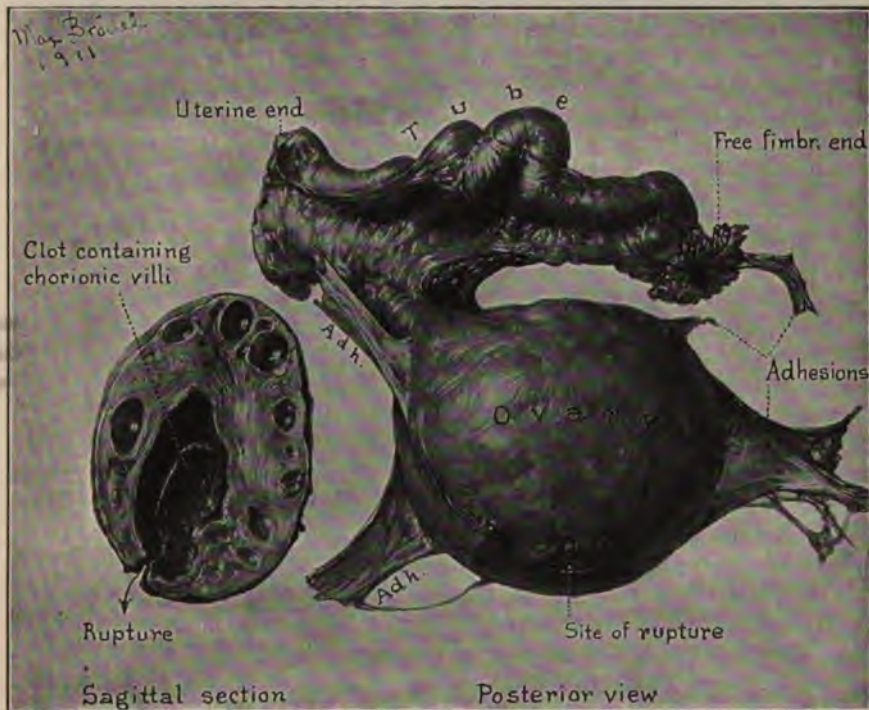


FIG. 504.—DR. E. K. CULLEN'S SPECIMEN OF OVARIAN PREGNANCY. XI.

1835, when Velpeau stated that none of the cases which had been described up to that time afforded conclusive evidence of ovarian origin. Similar views were expressed by Mayer in 1847, and were indorsed by Pouchet, Allan Thompson, and others. This scepticism was probably quite justifiable, since most of the early cases collected by Campbell and Gurgui were simply dermoid cysts of the ovary.

With the exception of Mayer, the possibility of ovarian pregnancy has always been admitted by the German writers, but was strenuously denied until 1901 by the English authorities, particularly by Tait, Webster, and Bland Sutton.

Indeed, as far as I can ascertain, only 3 cases were reported in England during the nineteenth century, namely, 2 by Granville in 1834 and 1 by Oliver in 1896. In this country most writers have followed the English



authorities, although Parry admitted its existence and not a few operators have reported doubtful cases; but it was not until 1902 that Thompson demonstrated a perfectly conclusive specimen.

Up to 1878 there existed no definite criteria by which specimens could be judged, and many were described as examples of ovarian pregnancy which had no claim to such a title. In that year, however, Spiegelberg formulated certain criteria which he held must be fulfilled in order to justify such a diagnosis. He demanded (1) that the tube on the affected side be intact; (2) that the foetal sac occupy the position of the ovary; (3) that it be connected with the uterus by the ovarian ligament; and (4) that definite ovarian tissue be found in its wall. When judged by these criteria, the majority of cases which had been described up to his time were found wanting, and subsequent investigation has shown that a number of cases which he considered conclusive are likewise open to very considerable doubt.

At present the possibility of ovarian pregnancy is universally admitted, and even so rigorous a critic as Webster has abandoned his scepticism, and has reported two authentic cases.

I have carefully gone over the literature upon ovarian pregnancy, and have classified the cases reported up to January, 1906, as positive, highly probable, fairly probable, and doubtful, according to the extent to which Spiegelberg's criteria were fulfilled. I was able to find 13 specimens belonging in the first, and 17 in the second, category. The former were thoroughly described, and so carefully studied microscopically that their ovarian origin was conclusively demonstrated; namely, the cases of Gottschalk, 1893; Ludwig, 1896; Kouwer and Tussenbroek, 1899; Croft, 1900; Anning and Littlewood, 1901; Robson, 1902; Franz, 1902; Thompson, 1902; Mendes de Léon and Holleman, 1902; Micholitsch (2 cases), 1903; Boesebeek, 1904; and Webster, 1904. The patients of Gottschalk and Ludwig had gone to term, but in none of the other 11 had the pregnancy progressed beyond the fourth month. Since 1906 many more positive cases have been described, and important contributions made to the subject by Bryce, Kerr and Teacher, C. C. Norris, Lea, and others.

It is interesting to note that in one third of the 30 positive or highly probable cases, which I collected, the pregnancy had gone to full term, and in several instances had eventuated in the formation of lithopædia, which had been carried for years before being removed. This would appear to indicate that the ovary can accommodate itself more readily than the tube to the growing pregnancy; but at the same time it should be remembered that rupture at an early period is the usual termination, as is shown by the fact that 11 of the 13 positive cases had not progressed beyond the fourth month. It is also important to bear in mind that the pregnancy may be destroyed at any early period without rupture, and give rise to a tumor of varying size, consisting of a capsule of ovarian tissue inclosing a mass made up of blood and chorionic villi, which may or may not contain an amniotic cavity, as in the specimens of Mendes de Léon and Webster. Such observations render it probable that a certain proportion of ovarian hæmatomata may actually represent the remains of an early pregnancy, but such a

diagnosis should not be considered unless microscopical examination reveals the presence of chorionic villi.

In ovarian pregnancy, the ovum itself and its mode of implantation do not differ eventually from that observed in the uterus, except that a definite decidua is lacking, so that the foetal ectoderm invades the ovarian stroma directly and opens up its blood-vessels.

**Tubal Pregnancy.**—In this, by far the most frequent, variety of extra-uterine pregnancy, the ovum may develop in any one of the three portions of the tube, giving rise to interstitial, isthmic, or ampullar pregnancy respectively. In rare instances it may be implanted upon the fimbriated extremity, and occasionally even upon the fimbria ovarica. From these

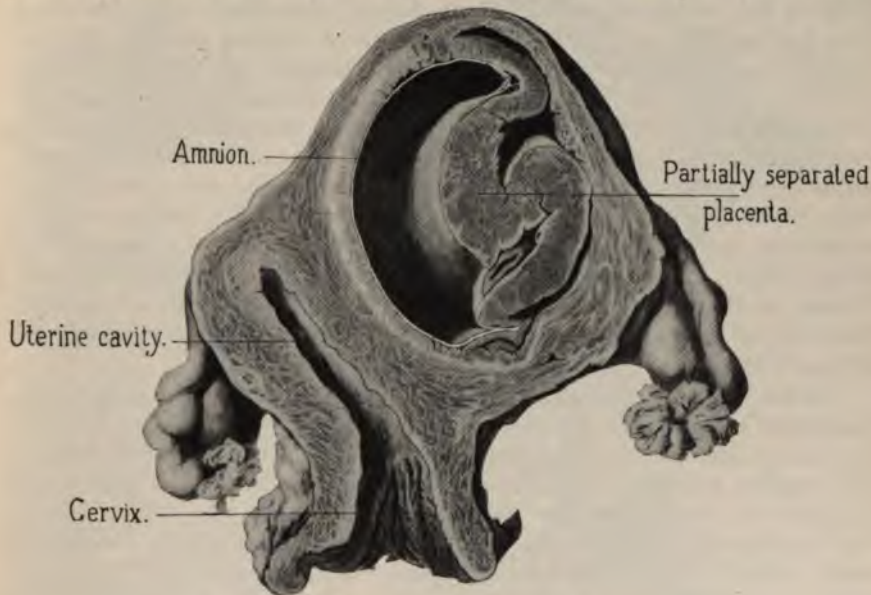


FIG. 505.—INTERSTITIAL PREGNANCY (Bumm).

primary types certain secondary forms—tubo-abdominal, tubo-ovarian, and broad-ligament pregnancy—occasionally develop.

According to Rosenthal, the interstitial is the rarest variety, having occurred in only 3 per cent. of the 1,324 cases of tubal pregnancy which he collected from the literature, while Lequeux was able to collect 75 cases up to 1911. Of 57 cases analyzed by Martin and Orthmann, 48 were ampullar, 8 isthmic, and only 1 was interstitial. Most recent writers state that the isthmic variety is the commonest, and this has also been my experience.

**Anatomical Considerations.**—(a) *Mode of Implantation of the Ovum.*—Formerly it was taught that the implantation of the ovum, whether in the uterus or tube, was dependent upon the formation of a well-developed decidua. The work of Graf Spee and Peters, however, has demonstrated that even in the uterus this is not necessary, and has shown clearly that the ovum burrows down into the depths of an oedematous endometrium,



whose stroma cells have not yet assumed a characteristic decidual appearance. This work, which has completely revolutionized our conception of the mode of implantation of the ovum and the development of the placenta in uterine pregnancy, applies equally well to the tube, although certain anatomical peculiarities of the latter usually necessitate a different outcome.

The ovum may become arrested in any portion of the tube, and, according to Werth, may become implanted in either one of two varieties. In the first, or columnar, variety, which is very rare, the ovum becomes attached to the tip or side of one of the folds of the mucosa; while in the second, or intercolumnar variety, implantation occurs in a depression between two folds at the peripheral portion of the lumen. In either event, the ovum does not remain upon the surface, but at once burrows through the epithelium, and comes to lie in the tissue just beneath it. By that time its periphery is made up of a capsule of rapidly proliferating ectodermal cells—the trophoblast—which soon invade the surrounding tissues. It is generally believed that the erosive properties of the trophoblastic cells bring about degeneration of the muscle and connective-tissue cells, which eventually become converted into fibrin. At the same time the blood-vessels are opened up, and the maternal blood is poured out into spaces of varying size lying entirely within the trophoblast, or between it and the adjacent tissue. Young, on the other hand, considers that œdema and necrosis occur before the maternal tissue is reached by the foetal cells, and are probably due to the action of chemical substances secreted by the latter.

In the usual, intercolumnar mode of implantation, as soon as the ovum penetrates the epithelium it comes to lie in the muscular wall of the tube, and is separated from the lumen by a layer of tissue of varying thickness—the capsular membrane or pseudo-reflexa (Fig. 508). On the other hand, in the very rare columnar mode of implantation, the ovum lies in the interior of a fold of mucosa, and except at its base is surrounded on all sides by tubal epithelium, so that it has but slight space for expansion.

Every specimen of early tubal pregnancy, which I have studied in recent years, has served to strengthen my belief that the implantation occurs in practically the same manner as in uterine pregnancy. That this view is correct is shown by the fact that it has been endorsed by Füh, Griffiths, Aschoff, Kühne, Kreisch, Petersen, Andrews, Couvelaire, Lockyer, Werth, Pfannenstiel, Krömer, Voigt, Kermauner, Berkeley and Bonney, Wallgren, and many others.

The further development of the pregnancy depends in great part upon the portion of the tube in which implantation has occurred. When in the ampulla, the growing ovum pushes forward the capsular membrane into the tubal lumen, which eventually may become so compressed as to appear as a mere crescentic slit, whose walls are almost in apposition. If the course of the pregnancy be not interrupted, the capsular membrane may fuse with the neighboring mucosa, so that the lumen of the tube may become obliterated in the immediate vicinity of the ovum.

On the other hand, when implantation occurs in the isthmus, and par-

ticularly in the portion immediately adjoining the uterus, the small size of the lumen precludes the possibility of such expansion, and as a consequence the ovum distends the tube wall peripherally to its lumen, so that the latter may eventually become completely separated from the underlying muscularis and be surrounded by foetal tissue and villi.

(b) *Decidua*.—Bland Sutton in 1891, and Fütth and Griffiths a few years later, pointed out that the decidual reaction in the tube was nothing like so extensive as was generally believed; while Kühne, Aschoff, and Kreisch were sceptical of its existence, and contended that the cells, which



FIG. 506.—SECTION SHOWING ATTACHMENT OF CHORION TO TUBE WALL. X90.

*Dec.*, decidual cells; *L. C.*, Langhans's cells; *Syn.*, syncytium; *V.*, villi.

had formerly been described as decidual, were really of foetal origin. These contentions have been sustained by most subsequent observers, so that at present no one claims that a distinct continuous decidual membrane is formed.

On the other hand, it is equally erroneous to contend that a decidual reaction is always lacking, as it is possible by careful study to distinguish decidual cells, and to differentiate clearly between them and foetal cells. The former are usually found in discrete patches in the tips of some of the folds of the mucosa in the neighborhood of the ovum. Furthermore, careful study will occasionally enable one to distinguish decidual cells scattered



between the foetal tissues at the placental site (Fig. 506), but I have never observed a decidual membrane analogous to the decidua vera or serotina in uterine pregnancy.

That the authors who deny the existence of decidual cells in the tube take too extreme a view is shown by the fact that they have been repeatedly observed by Webster, Voigt, Both, Couvelaire, Dobbert, Petersen, Lange, Kermauner, Young, myself, and others. Moreover, the possibility of a decidual reaction is demonstrated by the fact that characteristic decidual



FIG. 507.—SECTION SHOWING FORMATION OF DECIDUAL CELLS IN RIGHT TUBE, WHILE THE PREGNANCY WAS IN THE OPPOSITE TUBE; CONCLUSIVELY DEMONSTRATING THAT THEY COULD NOT BE OF FOETAL ORIGIN.

*m.m.*, tubal mucosa; *musc.*, muscularis; *d.*, decidua.

cells are sometimes observed in the non-pregnant tube (Fig. 507). Observations of this character by Webster, Mandl, Goebel, Janot, Krömer, and myself are beyond criticism, as in such cases it is impossible to confuse decidual with foetal cells. Furthermore, Mandl, Lange, and I have noted an identical reaction in the tubes in certain cases of uterine pregnancy.

The absence, or comparative scantiness, of the decidual reaction is of interest not only from a scientific point of view, but also has a distinctly practical bearing, as it would seem to offer a satisfactory explanation for the invasion and destruction of the tube wall by the foetal elements. In

uterine pregnancy, such an invasion is noted only in the rare instances in which there is an imperfect development of the decidua, and it would therefore appear that one of the main purposes of the latter is to protect the maternal tissues against the invasive and corrosive action of the foetal cells.

(c) *Decidua Reflexa*.—Since the time of Rokitansky, the question as to the existence of a decidua reflexa in tubal pregnancy has been repeatedly discussed, one set of investigators claiming that it is usually present and the other set holding that it is always absent. The investigations of the past few years have served to reconcile these differences.

In view of the general scantiness of the decidual reaction, it is evident that one could not reasonably expect the formation of a structure identical with the decidua reflexa of uterine pregnancy. On the other hand, in all intact early tubal pregnancies, the ovum is separated from the lumen of the tube by a thicker or thinner layer of connective and muscular tissue, with possibly a few isolated decidual cells (Fig. 508). As the pregnancy advances this membrane becomes invaded by foetal cells, and later undergoes fibrinous degeneration, and, if rupture does not occur, eventually becomes fused with the mucosa of the opposite side of the tube. As this structure is only superficially analogous to the decidua reflexa, it is better designated as the pseudo-reflexa or capsular membrane.

(d) *Placenta*.—As the early stages of the development of the placenta are identical in both tubal and uterine pregnancy, the different outcome in the former is dependent upon the absence or scanty development of a decidual reaction. As a consequence, the tissues of the tube wall in contact with the ovum offer but slight resistance to the invasive properties of the foetal elements, and soon undergo degenerative changes. The chorionic villi and foetal cells invade this tissue, almost like a malignant growth, and open up maternal blood-vessels. In many cases they penetrate directly through the peritoneal surface or the capsular-membrane, as the case may be, and



FIG. 508.—EARLY TUBAL PREGNANCY, SHOWING OVUM EMBEDDED IN WALL OF TUBE OUTSIDE OF LUMEN. X6.

b.c., blood-clot; v., chorionic villi; refl., capsular membrane.



give rise to intra-peritoneal hæmorrhage or tubal abortion. In other instances, however, early rupture is due to the sudden opening up of a large vessel, when the weakened tube walls yield to the increased pressure. Werth has quaintly expressed the condition by stating that the ovum, in making its bed, digs its own grave.

The microscopic structure of the foetal portion of the placenta is identical with that observed in uterine pregnancy (Fig. 506). Even more frequently than in that condition masses of Langhans's cells, syncytium, or even fragments of villi become broken off from the placenta, and are carried by the veins to various portions of the body. This process of deportation can be demonstrated in almost every case by cutting serial sections through the tube (Fig. 457). Veit has still further extended this conception by applying it to the growth into venous channels of chorionic villi, which still retain their connection with the placenta. He considers that it plays an important part in the production of rupture, as such a clogging of the venous channels may so raise the pressure in the intervillous spaces that the weakened tube walls necessarily give way.

It is stated by Gubb and others that the placenta may continue to grow after the death of the foetus. I, however, agree with Berry Hart, that it is out of the question, except in the rare cases of hydatidiform mole formation; although it must be admitted that in advanced tubal pregnancy hæmorrhage occasionally takes place into the placenta, and thus leads to a considerable increase in its size.

(e) *Structure of the Foetal Sac.*—In extra-uterine pregnancy there is a marked increase in the vascularity of the affected tube, the larger arteries and veins being much hypertrophied, while the smaller vessels, especially in the neighborhood of the placental site, are markedly engorged.

Microscopical sections through the sac in the early months show a slight hypertrophy of the muscle cells, but no apparent increase in their number. Except at the placental site, the tube wall is considerably thickened, and its cells are spread apart by œdema. At a still more advanced period, the muscular constituents of the gestation sac appear to diminish in number, so that at full term almost its entire thickness is made up of a connective tissue poor in cells, with only here and there a muscle fiber. This indicates that the muscularis of the tube does not possess the same tendency to hypertrophy as that of the uterus, though occasionally it is quite marked, Pinard having reported a case in which the foetal sac contracted so strongly that he mistook it for a pregnant uterus.

In most cases the exterior of the tube gives evidence of peritonitic involvement, and a considerable portion of the thickness of the foetal sac is often due to peritoneal adhesions.

In order for complete tubal abortion to occur, the fimbriated extremity must remain patent, but in other cases its condition varies, being sometimes closed, sometimes open. As a rule, the lumen of the tube communicates directly with either end of the foetal sac. Less commonly, however, this communication is noted only at one end, while still more rarely the foetal sac is completely shut off from the main lumen. A satisfactory explanation of these differences has not yet been adduced.

(f) *Uterine Changes.*—In the first three months the uterus undergoes considerable hypertrophy, and its endometrium becomes converted into a decidua similar to that observed in uterine pregnancy, and differing from it only in a less marked development of the spongy layer and a greater abundance of blood spaces just beneath its free surface. Soon after the death of the foetus, the decidua is thrown off in small pieces, and occasionally as a triangular cast of the uterine cavity. Its discharge is usually considered of marked diagnostic significance; so much so that in doubtful cases many observers recommend curetting the uterus, and base their diagnosis upon the presence or absence of decidual tissue.

*Terminations of Tubal Pregnancy.*

—According to Tait, the universal fate of tubal pregnancy was rupture either into the peritoneal cavity, or between the folds of the broad ligament, occurring not later than the twelfth week. More careful study has demonstrated the incorrectness of such a statement, as the great majority of cases terminate at an early period by abortion after rupture through the capsular membrane. Very exceptionally, the pregnancy may go on to full term without rupture, as in the cases reported by Saxtorph, Spiegelberg, Chiari, Gutzwiller, Emanuel, Freund, and others. My collection also contains a similar specimen.

(a) *Tubal Abortion (Intra-tubal Rupture.)*—After Werth, in 1887, had directed attention to the possibility of tubal abortion, it has gradually been demonstrated that this is by far the most frequent outcome of tubal pregnancy. The marked change of opinion which has taken place upon this point is readily appreciated by comparing the statements made by Schrenck and Werth, in 1892 and 1904, respectively. The former found only 6 cases of abortion in 610 cases of tubal pregnancy collected from the literature; whereas the latter stated that seven out of eight cases end in that way and only one by rupture. According to Martin, "this termination is the general rule, spontaneous rupture occurring only in those cases in which occlusion of the abdominal end of the tube precludes the possibility of an abortion, or in which the ovum, being inserted in a hernia of mucosa, burrows directly through the tube wall."

The frequency of tubal abortion depends in great part upon the site of implantation of the ovum. In ampullar pregnancy, it is the general rule, whereas intra-peritoneal rupture is the usual outcome in isthmic pregnancy. This difference is probably due to the fact that in the former the tubal lumen is sufficiently patulous to permit of a considerable degree of expansion



FIG. 509.—UTERINE DECIDUA FROM A CASE OF EXTRA-UTERINE PREGNANCY (Zweifel).



of the foetal sac, whereas in the latter the lumen is so small that this is impossible; and as expansion can occur only toward the periphery, early rupture is the usual termination.

Tubal abortion results from the perforation or rupture of the capsular membrane or pseudo-reflexa, and therefore does not differ essentially from



FIG. 510.—EARLY TUBAL PREGNANCY, WITH ABORTION OF OVUM INTO LUMEN OF TUBE.  $\times 6$ .

*b.c.*, blood-clot; *v.*, chorionic villi.

intra-peritoneal rupture, except in the fact that in the one case the hæmorrhage occurs into the lumen of the tube, whereas in the other it takes place into the peritoneal cavity. Accordingly, the term "tubal abortion" could be well replaced by that of intra-tubal rupture, as suggested by Berkeley and Bonney.

The immediate consequence of the hæmorrhage is the loosening of the connection between the ovum and the tube wall, the former becoming completely or partially separated from its site of implantation. If the separation is complete, the entire ovum is extruded into the lumen of the

tube, and gradually forced by the effused blood toward the fimbriated end, through which it may be extruded into the peritoneal cavity, whereupon the hæmorrhage usually ceases. On the other hand, if the separation is only partial, the ovum remains *in situ*, and the hæmorrhage continues. Accordingly, we distinguish between *complete* and *incomplete abortions*, the latter occurring far more frequently than the former—10 to 1, according to Wormser.

In a small number of cases the ovum may be observed in the act of abortion (Fig. 511). Thus, among my own specimens are several which



FIG. 511.—TUBAL ABORTION, OVUM BEING EXTRUDED THROUGH FIMBRIATED EXTREMITY (Kelly).  $\times 1$ .

show the fœtus surrounded by its membranes, protruding from the dilated fimbriated extremity of the tube.

When the hæmorrhage is moderate in amount and the ovum remains *in situ*, it may become infiltrated with blood and increase markedly in size, being converted into a structure analogous to the blood or fleshy mole observed in uterine abortions (Fig. 512). The hæmorrhage usually persists as long as the mole remains in the tube, and the blood slowly trickles from the fimbriated extremity into the peritoneal cavity, where it becomes encapsulated, giving rise to an *hæmatocele*. If the fimbriated extremity is occluded, the tube may gradually become distended by blood—*hæmatosalpinx*.

After incomplete abortion, small particles of the chorion may remain attached to the tube wall and, becoming surrounded by fibrin, give rise to a placental polypus, just as is often noted after an incomplete uterine abortion.

(b) *Rupture into the Peritoneal Cavity*.—Somewhat less than one eighth of the cases of tubal pregnancy end within the first twelve weeks by intraperitoneal rupture, which usually occurs spontaneously, but occasionally is the result of violence. Generally speaking, when rupture occurs in the first few weeks, the pregnancy is situated in the proximal end of the tube, a short distance from the cornu of the uterus (see Fig. 513). On the



other hand, when the ovum is implanted in the interstitial portion of the tube, rupture occurs later than in the other varieties—as a rule, not until after the fourth month, sometimes considerably later. This difference is due to the fact that the interstitial portion of the tube is surrounded by a thick layer of uterine musculature, which reacts promptly to the stimulation of pregnancy, and by its hypertrophy allows the ovum to attain a considerable size before rupture occurs.



FIG. 512.—SECTION THROUGH TUBAL MOLE.  $\times 1$ .

B.C., blood-clot; Ov., ovum; T.W., tube wall; U.T., uterine end of tube.



FIG. 513.—ISTHMIC PREGNANCY. RUPTURE TEN DAYS AFTER LAST MENSTRUAL PERIOD.  $\times 1$ .

The prime factor in the causation of rupture is the intra-mural embedding of the ovum, and the consequent invasion and weakening of the tube wall by the ectodermal elements and chorionic villi. Its direct cause may be violence, such as vaginal examination, coitus, a fall, or even mere overexertion, though in the great majority of cases it occurs spontaneously. In such circumstances, rupture is brought about either by direct perforation by the growing villi, or by the weakened tube wall yielding to a sudden access of pressure in the inter-villous spaces, following the sudden opening up of a large vessel or the clogging of venous channels by chorionic villi. The evidence at present available seems to indicate that the former is the less usual factor.

If rupture occurs in this way in an otherwise normal tube, it is apparent that it will be likely to occur at a much earlier period if the ovum be arrested in a diverticulum from its lumen, as under such circumstances it will have only a portion of the tube wall to penetrate, instead of its entire thickness.

Occasionally, secondary rupture may occur in a tube the seat of a primary abortion, though this is possible only when the fimbriated end is occluded. Under such circumstances the weakened tube wall yields to the pressure of the blood, which has been poured into its lumen and can find no other means of escape.

Rupture usually occurs in the neighborhood of the placental site, and either into the peritoneal cavity or between the folds of the broad ligament, depending upon the original site of the ovum. The terminations of the two conditions differ so markedly that it will be necessary to consider them separately.

In the former accident, the entire ovum may be extruded from the tube, but if the rent be small, profuse hæmorrhage may occur without its escape.

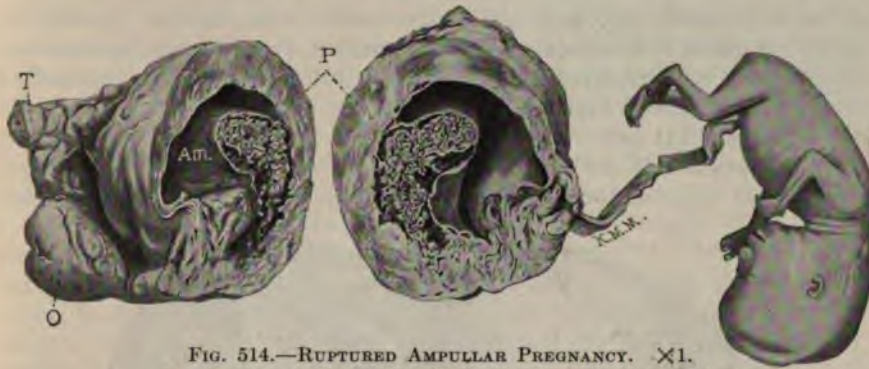


FIG. 514.—RUPTURED AMPULLAR PREGNANCY.  $\times 1$ .  
Am., amnion; O., ovary; P., placenta; T., uterine end of tube.

In either event, the patient immediately shows signs of collapse, which may rapidly end in death. If this does not occur, the effect of rupture varies according to the amount of damage sustained by the ovum. If expelled intact into the peritoneal cavity, the death of the foetus is inevitable; and unless the pregnancy has advanced beyond the third month, the product of conception will be rapidly absorbed, as was shown by Leopold's experiments upon animals.

It is still thought by many that in such circumstances the placenta may become attached to any portion of the peritoneal cavity, and there establish vascular connections, which will render further development possible. I do not believe that this can occur, as it is highly improbable that such connections could be established before the ovum had become irreparably damaged, not to speak of the negative evidence afforded by the experiments just mentioned.

On the other hand, if only the foetus escapes at the time of rupture, the effect upon the pregnancy will vary according to the amount of injury sustained by the placenta. If much damaged, death of the foetus and termination of the pregnancy is inevitable; but if the greater portion of the placenta still retains its attachment to the tube, further development is possible, and the foetus may go on to full term, giving rise to a secondary abdominal pregnancy. In such cases, the tube may close down upon the placenta and form a sac, in which it remains during the rest of the pregnancy. Or, a portion of the placenta may remain attached to the tube wall, while its growing periphery extends beyond it and establishes connection with the surrounding pelvic organs. Under such circumstances one may find the placenta attached partly to the uterus, pelvic floor, rectum, or even the intestines.

I do not believe, however, that the placenta can become directly attached to organs far removed from the pelvic cavity, such as the stomach and diaphragm, for instance; and when such connections are observed, I consider that one has to deal with a broad-ligament pregnancy, in which the



placenta is situated upon the upper portion of the foetal sac, which had become adherent to the organ in question.

When the foetus escapes from the tube it is nearly always surrounded by its membranes, and most authorities believe that further growth is impossible unless it is surrounded by the amnion, though several observers, notably Roth, have reported cases in which a full-term foetus lay perfectly free in the peritoneal cavity, and all that was left of its membranes was found in the tubal sac.

(c) *Rupture into the Broad Ligament.*—In a small number of cases, rupture may occur at the portion of the tube uncovered by peritoneum, so



FIG. 515.—BROAD-LIGAMENT PREGNANCY (Zweifel).

that the contents of the gestation sac are extruded into a space formed by the separation of the folds of the broad ligament. Generally speaking, this is the most favorable variety of rupture, and may terminate either by the death of the ovum and the formation of a *broad-ligament hematoma*, or by the further development of the pregnancy.

The outcome depends largely upon the degree of completeness with which the placenta has been separated. If it remains attached to the tube on the side opposite the point of rupture, it generally becomes displaced upward as pregnancy advances, and comes to lie above the foetus; but when it is situated near the point of rupture it gradually extends down between the folds of the broad ligament, being implanted partly upon the tube and partly upon the pelvic connective tissue. In either event, the foetal sac lies entirely outside of the peritoneal cavity, and as it increases in size the peritoneum is gradually dissected up from the pelvic and abdominal walls. This condition is designated as *extra-peritoneal* or *broad-ligament pregnancy*, and was carefully studied by Dezeimeris in 1836. Occasionally, the broad-ligament sac may rupture at a later period, and the child be

extruded into the peritoneal cavity, while the placenta retains its original position—*secondary abdominal pregnancy*.

The importance of rupture into the broad ligament was particularly emphasized by Tait, who believed that it was only under such circumstances that extra-uterine pregnancy could go on to full term. But since only a small proportion of cases of tubal pregnancy end in rupture, it is evident that his statements were based upon imperfect information. The frequency of this mode of rupture has been considerably overestimated, as it was noted in only 4 out of 276 cases collected from the articles of Mandl and Schmidt, Küstner, and Fehling, and only once in my series of cases.

The so-called *tubo-uterine pregnancy* results from the gradual extension into the uterine cavity of an ovum which was originally implanted in the interstitial portion of the tube. *Tubo-abdominal pregnancy*, on the other hand, is derived from a tubal pregnancy in which the ovum has been inserted in the neighborhood of the fimbriated extremity, and gradually extended into the peritoneal cavity. In such circumstances, the portion of the foetal sac projecting into the peritoneal cavity forms adhesions with the surrounding organs, which often seriously complicate its removal at operation. Neither of these conditions is very common, nor do they deserve to be classified separately; in reality, they are merely pregnancies developing at unusual portions of the tubes.

The term *tubo-ovarian pregnancy* is employed when the foetal sac is composed partly of tubal and partly of ovarian tissue. Such cases owe their origin to the development of an ovum in a tubo-ovarian cyst, or in a tube whose fimbriated extremity was adherent to the ovary at the time of fertilization. They are therefore primarily either tubal or ovarian in origin.

**Abdominal Pregnancy.**—In the earlier literature it was generally stated that the ovum could be implanted upon any portion of the peritoneum, giving rise to a primary abdominal pregnancy, and in Hecker's statistics it was recorded twice as frequently as the tubal variety. Later, however, when the specimens were more carefully studied, it became apparent that the great majority of abdominal pregnancies were secondary in character, having resulted from ruptured tubal pregnancy.

Gradually doubt began to be cast upon the existence of primary abdominal pregnancy, so that at present most authors, while admitting its theoretical possibility, are extremely sceptical as to its actual occurrence. Bland Sutton positively denies its occurrence in women, and contends that it is not observed in the lower animals. Hirst and Knipe in 1908, and Gröne in 1909, however, described specimens, which, while not entirely convincing, so nearly fulfill the requisite criteria that it became necessary to reckon with this variety of extra-uterine pregnancy from a practical point of view.

Occasionally, as was shown by Zweifel, Martin, Voigt, Leopold, and Werth, the fertilized ovum may become implanted upon the fimbria ovarica. Such conditions may closely resemble primary abdominal pregnancy, inasmuch as the surface upon which the ovum is primarily implanted is so small that the margins of the placenta soon extend beyond it and become



attached to the surrounding organs, thus giving the impression that the peritoneum was the original site of implantation. A careful microscopical examination, however, will usually enable one to differentiate between the two conditions.

**Fate of Extra-uterine Fœtus.**—As has already been pointed out, absorption is the universal fate of small embryos which are extruded into the peritoneal cavity, unless the placenta retains its attachment to the tube wall and still offers conditions suitable for the continuance of the circulation. Moreover, the young fœtus is frequently absorbed while still within the tube, as is shown by the fact that, upon opening early gestation sacs, it is sometimes represented by an amorphous mass of tissue attached to the umbilical cord. At times the only indication of its previous existence is found in a small stub of cord hanging free in the amniotic cavity. On the other hand, when the fœtus has attained a certain size before death it cannot be absorbed in this manner, and must undergo suppuration, mummification, calcification, or adipocere transformation.

Pyogenic bacteria often gain access to a gestation sac, which is adherent to the intestines, and give rise to *suppuration* of its contents. Eventually the abscess perforates at the point of least resistance, and if the patient does not die from septicæmia, portions of the fœtus may be extruded through the abdominal wall or into the intestines or bladder, according to the situation of the perforation. This outcome is particularly frequent in broad-ligament pregnancies, on account of their proximity to the rectum and the liability to infection by intestinal bacteria.

*Mummification* and *lithopædion formation* have already been referred to in the chapter on Abortion, and are dealt with fully in Küchenmeister's article. The latter is generally regarded as the most favorable of the possible eventualities in cases of advanced extra-uterine pregnancy, as in many instances the calcified product of conception may be carried for years as a benign foreign body, and do no harm unless it gives rise to dystocia in a subsequent pregnancy. In several instances a lithopædion has been known to remain in the abdomen for fifty years or more, and the literature contains numerous cases in which a period of twenty to thirty years elapsed before its removal at operation or autopsy.

Much more rarely the fœtus may become converted into a yellowish greasy mass to which the term *adipocere* is applied. The fatty material is supposed to be an ammoniacal soap, but a satisfactory explanation of its formation has not as yet been advanced.

*Diseases of Extra-uterine Ovum.*—If an extra-uterine pregnancy goes on without interruption beyond the first few weeks, the ovum is exposed to all the diseases which may occur in the ordinary uterine form. Thus, Schauta, Wertheim, and Micholitsch have described tubal ova which had become converted into hæmatoma moles. Hydatidiform moles have been observed by Otto, Recklinghausen, Wenzel, Sykow, and others; and hydramnios by Teuffel, Webster, and others. Ahlfeld and Marchand first described a case of chorio-epithelioma following tubal pregnancy, and Risel, in 1905, was able to collect ten additional cases from the literature. It is interesting to note that Spiegelberg and Holst observed the occurrence



of eclampsia during the false labor in cases of advanced extra-uterine pregnancy.

**Symptoms.**—Unfortunately, the manifestations belonging to an uninterrupted extra-uterine pregnancy are not characteristic, and the patient and her physician are usually entirely unaware of the existence of any abnormality until death of the foetus, rupture, or tubal abortion occurs. Ordinarily the patient considers herself pregnant, presents the usual subjective symptoms, and possibly suffers from slight pains in one or other ovarian region, which she regards as the usual concomitants of her condition. In rare instances, indeed, she may have no idea that she is pregnant, and rupture may occur and perhaps prove fatal, even before she has missed a single menstrual period.

Suppression of the menses is not associated so regularly with this condition as with normal pregnancy, being noted in only 43 per cent. of the cases observed by Martin and Orth, Mandl, Bouilly, and Wormser. These statements, however, do not carry as much weight as would appear at first sight, for frequently the hæmorrhage does not represent a genuine menstrual flow, but is due to endometritis, or to the fact that the dilated vessels in the uterine decidua are not covered by a layer of foetal tissue. Moreover, the death of the extra-uterine foetus at an early period, if not accompanied by rupture or abortion, is usually associated with more or less uterine hæmorrhage, which is frequently mistaken for the menstrual flow or for an early abortion, the latter belief being still further confirmed by the discharge of decidua.

In many cases the first manifestation of the abnormal pregnancy is the sudden occurrence of intense, lancinating pain in one or other ovarian region, which is soon followed by faintness, the patient rapidly passing into a condition of collapse. This indicates the occurrence of rupture or abortion. In the former case the collapse deepens, the face becomes pallid, and the patient complains of intense pain in the lower abdomen. The temperature may be persistently subnormal, and an examination of the blood shows a marked diminution in the number of red corpuscles and in the amount of hæmoglobin. Death may occur within a few hours unless the hæmorrhage is checked by operative means. On the other hand, in most cases of abortion, the patient rallies promptly, the general condition is not so alarming, and gradual recovery ensues. Vaginal examination a few days later frequently reveals the presence of a large fluctuant mass which fills a greater or lesser portion of the pelvic cavity—*pelvic hæmatocele*.

Formerly hæmatocele was considered as a distinct disease, and it was mainly owing to Veit's observations that its connection with extra-uterine pregnancy was established. It is described as *diffuse* or *solitary*, according as the collection of blood occupies a considerable portion of the pelvic cavity or is confined to the neighborhood of the fimbriated end of the tube. The diffuse variety usually occurs when preëxisting adhesions about the pelvic organs facilitate the coagulation of blood and aid in the formation of an organized membrane over it, thus shutting it off from the peritoneal cavity. According to Säger, the solitary hæmatocele, on the other hand, does not require the presence of adhesions for its formation, but results



from the gradual trickling of blood from the fimbriated end of the tube, the outer portions gradually coagulating and becoming organized, thus forming a capsule about the more fluid portions.

Hæmatocele formation, for the most part, promises a very favorable termination, for if left alone the mass gradually undergoes absorption and complete recovery occurs. Thorn has reported 157 cases with two fatalities, and Fehling 91 cases without a single death. Occasionally, however, if the hæmorrhage persists, the hæmatocele becomes larger and larger until it finally ruptures and its contents are poured out into the peritoneal cavity. Such an accident is speedily followed by collapse. Again, bacteria sometimes make their way into the mass from the intestines and cause suppuration.

If the patient survives the rupture of a tubal pregnancy, a *secondary abdominal pregnancy* may result, provided the placenta has not been separated to too great an extent. Under such circumstances the usual symptoms of pregnancy persist, except that the woman suffers more pain and feels the foetal movements more acutely than usual. The pain is due partly to stretching and possibly to contractions of the foetal sac, but principally to traction upon adhesions which have formed between it and the various abdominal organs.

In a small number of cases in which the primary rupture has taken place between the folds of the broad ligament, *secondary rupture* into the peritoneal cavity may occur at a later period, and the patient may bleed to death, or a secondary abdominal pregnancy may result. In the latter event, the foetus lies within the peritoneal cavity, while the placenta remains partly within the tube and partly between the folds of the broad ligament.

If a secondary abdominal pregnancy, or, as now and again occurs, an unruptured tubal pregnancy, goes on to term, *false labor* sets in, associated with distinct pains similar to those occurring in the early stages of normal labor. They are due to uterine contractions, since the foetal sac contains so few muscular fibers that it cannot contract, and of course cannot lead to the birth of an extra-uterine child. False labor may last for a few hours or several days, and is soon followed by the death of the child, although in a small number of cases the foetal movements have been known to persist for a considerable time after the cessation of the pains.

After the death of the foetus, the placental circulation gradually becomes abolished, the amniotic fluid is absorbed, and the foetal sac retracts, so that it occupies a much smaller space than formerly. The abdomen consequently becomes smaller, and its change in size is soon noticed by the patient. After its initial shrinking, the tumor may remain stationary in size for a number of years, the child becoming mummified or converted into a lithopædion; while in rare instances suppurative changes may lead to its gradual discharge, or to the death of the patient from peritonitis.

**Combined and Multiple Pregnancies.**—Parry stated in his monograph that 22 out of the 500 cases of tubal pregnancy collected by him were complicated by a coexisting intra-uterine pregnancy. He designated the condition as *combined pregnancy*. The condition occurs quite frequently,



and has been investigated by Browne, Strauss, Zincke, Neugebauer, and many others. Strauss in 1898 was able to collect only 32 cases from the literature, while Weibel in 1905 had increased the number to 119, to which Neugebauer in 1907 added many more cases.

In rare instances twin tubal pregnancy has been observed, both embryos being sometimes found in the same tube, while in other cases there is a foetus in each tube, both showing the same development. Sanger and Krusen have reported cases of triplet tubal pregnancy.

**Repeated Tubal Pregnancy.**—Parry collected 8 cases in which tubal pregnancy had occurred a second time in the same patient, and stated that Primrose in 1594 was the first to describe such a condition. With the increased employment of abdominal surgery, the abnormality has been recognized quite frequently, the first series of cases was reported by Abel in 1893, and soon followed by those of Dorland, Weil, Varnier, and Pestalozza, the last author having collected 111 cases. In several instances only a few months had elapsed between the two pregnancies, while in others they were separated by an interval of several years.

**Effects of Extra-uterine Pregnancy upon Subsequent Childbearing.**—The presence of the products of an old extra-uterine pregnancy occasionally gives rise to dystocia, and necessitates the performance of a major obstetrical operation. Thus, in the cases reported by Hugenberger, Schauta, and Sanger, Cæsarean section was performed; while Hennigsen, Dibot, and Brossi induced premature labor, and Stein and Cheston resorted to craniotomy under similar circumstances.

As a rule, however, dystocia is not encountered, Funck-Brentano having collected 92 cases in which spontaneous labor occurred in patients still carrying the remains of a previous extra-uterine pregnancy.

**Diagnosis.**—Unfortunately, the symptoms to which uninterrupted extra-uterine pregnancy gives rise are usually so slight that the woman does not consult a physician, and as a result the diagnosis is rarely made before rupture or abortion occurs. If, however, a patient, presenting the usual subjective and some of the objective symptoms of pregnancy, be examined, for any reason, and a unilateral tubal tumor be found, the diagnosis is fairly certain, especially if she has been sterile for a number of years or a long interval has elapsed since her last pregnancy. In such cases the uterus is somewhat enlarged and softened, while the tubal tumor is soft and doughy, and corresponds roughly in size to the supposed duration of pregnancy. The first positive diagnosis of unruptured tubal pregnancy was made by Veit in 1883, and in this country by Janvrin in 1886.

As a matter of fact, however, it usually happens that when laparotomy is performed for a supposed unruptured, early tubal pregnancy a tumor of some other origin is found. On the other hand, the unruptured pregnant tube may prolapse into Douglas's *cul-de-sac* and be mistaken for the body of a retroflexed pregnant uterus, in which event an attempt at its reposition may lead to rupture and occasionally to death.

When the foetus has died before the occurrence of rupture or abortion, errors in diagnosis are common, and many cases are mistaken for incomplete uterine abortions or for tubal tumors associated with uterine hæm-



orrhage. For this reason, no attempt should ever be made to empty the uterus in a case of suspected incomplete abortion, unless the tubes and ovaries have been previously palpated. If a careful examination shows that a tumor is present on either side, the possibility of tubal pregnancy should be seriously considered.

It is generally taught that the discharge of a distinct decidual cast from the uterus, without evidence of a foetus, is a characteristic sign of tubal pregnancy. But that such a structure now and again may be discharged without the existence of pregnancy of any kind was demonstrated by Griffiths and Dakin. It is generally believed that the presence of decidual tissue in the uterus, in the absence of a foetus, affords conclusive evidence of the existence of tubal pregnancy, especially if a tumor mass can be detected on one side. In doubtful cases curettage is recommended for diagnostic purposes. My own experience has taught me that the presence of decidua in such circumstances usually affords strong presumptive evidence, but that its absence is not an equally convincing negative proof, for occasionally the decidua may have been cast off at an early period, and have been replaced by normal endometrium by the time the patient is examined.

The diagnosis of tubal abortion or rupture, on the other hand, usually offers no difficulty, and should be made without hesitation whenever a patient who is believed to be pregnant has complained of pain in the lower part of the abdomen, and suddenly becomes faint, deathly pale, and sinks into a state of collapse. If the collapse becomes more profound and the temperature is subnormal, rupture has probably occurred. On the other hand, if rapid recovery ensues, the probabilities are that one has to deal with an abortion, and the subsequent formation of an hæmatocele settles the question.

As has already been pointed out, rupture may occur at a very early period, even before the patient believes herself pregnant. In view of such a possibility, therefore, one should regard sudden collapse associated with symptoms of abdominal hæmorrhage in a woman during the childbearing period as *primâ facie* evidence of a ruptured tubal pregnancy. By so doing, and operating promptly in suitable cases, a number of lives will be saved which otherwise would inevitably be lost.

Very often the patient comes into the hands of the physician some time after she has recovered from the primary shock due to abortion or rupture. Under such circumstances vaginal examination will show a mass on one side of the uterus which is usually mistaken for pelvic inflammatory trouble. In a small number of cases, a fluctuant tumor can be felt posterior and lateral to the uterus, and when exploratory puncture through the vagina reveals the presence of a dark bloody fluid, the diagnosis of a pelvic hæmatocele or a broad-ligament hæmatoma is assured.

If the child has survived the rupture, the diagnosis of secondary abdominal pregnancy is rarely made until false labor supervenes, unless the physician's attention is particularly directed to the previous history of the case. If, however, a careful physical examination is made, the uterus will be found much smaller than it should be for the duration of the pregnancy,

and more or less displaced by the foetal sac, which makes up the greater part of the abdominal enlargement. Moreover, the child can be palpated much more readily than usual, and its movements are often very painful to the mother. In doubtful cases the introduction of a sound into the uterus is permissible.

The diagnosis of broad-ligament pregnancy can be made by finding the uterus pushed to one side by a tumor intimately connected with it, which at the same time depresses the vaginal vault, instead of being high up in the abdominal cavity.

The diagnosis of combined intra-uterine and extra-uterine pregnancy is rarely made until after rupture of the extra-uterine pregnancy, or the persistence of symptoms following the expulsion of the uterine foetus, leads to a very careful examination. The condition has never been diagnosed in the later months of pregnancy, although in several instances the presence of twins was recognized.

After extra-uterine pregnancy has passed full term, the diagnosis is usually easy, and is based upon the history of pregnancy followed by a false labor and a gradual decrease in the size of the abdomen. Examination shows the uterus to be practically normal in size, and displaced to a varying extent by a large tumor more or less intimately connected with it, in which the outlines of the child can occasionally be distinguished.

To recapitulate, a positive diagnosis is occasionally made before rupture, but in the vast majority of cases the condition escapes recognition until symptoms of collapse point to the probability of rupture or abortion. In advanced cases careful examination will usually disclose the real condition of affairs, and when full term has been passed the history is so characteristic that mistakes should scarcely occur.

**Treatment.**—As soon as an unruptured extra-uterine pregnancy is positively diagnosed, its immediate removal by laparotomy is urgently indicated, since rupture may occur at any time and the patient die from hæmorrhage before operative aid can be obtained. The importance of immediate operation cannot be too strongly emphasized, and all methods of treatment which aim at destroying the foetus and thus terminating pregnancy without operation are absolutely unjustifiable. This applies not only to the use of electricity, but also to the injection of various poisonous substances into the gestation sac. Even when such procedures are successful, the danger to the mother is by no means at an end, since rupture sometimes takes place after the death of the foetus; and, even if this accident does not occur, the retention of the product of conception renders the tube a useless organ.

Although Stephen Rogers, in 1867, seriously suggested the propriety of performing laparotomy for the purpose of checking hæmorrhage from a ruptured tubal pregnancy, Lawson Tait, in 1883, was the first to undertake such an operation. After he had demonstrated the ease with which it could be performed and the surprisingly good results obtained thereby, the procedure came into general use. Its beneficent results were clearly demonstrated by Schauta, who, after a careful study of the literature, in 1891,



found that 123 cases operated upon and 121 cases treated without operation presented a mortality of 5.7 and 86.9 per cent. respectively.

For these reasons, whenever we see a possibly pregnant woman in a state of profound collapse, and presenting a deathly pallor of the face, a subnormal temperature, and other symptoms of intra-abdominal hæmorrhage, immediate operation is demanded, unless, indeed, her condition is so desperate that death is imminent.

The abdomen should be opened rapidly, under cocaine anæsthesia if necessary. In many cases blood spurts from the abdomen as soon as the peritoneum is incised, and completely obscures the field of operation. In these circumstances, the hand passed down alongside of the uterus seizes the tubal mass, which is then clamped on either side by long forceps. The hæmorrhage having been controlled in this way, the blood-clots are removed and the field of operation is cleaned up, after which the operator will be able to remove the mass and replace the clamps by ligatures, under the guidance of the eye, at comparative leisure. After the fœtal sac has been taken away, it is not advisable to attempt to remove all the blood from the peritoneal cavity unless the patient's condition is fairly satisfactory.

Frequently the appendages on the opposite side may be the seat of chronic inflammatory lesions. Some discretion should be exercised as to their removal at this time, it being far better to allow them to remain than to prolong the operation if the patient is in a very bad condition. In desperate cases it is advisable to begin the subcutaneous or intravenous infusion of sterile salt solution while the necessary preparations for the operation are being made. In less severe cases good results follow the introduction of several liters of it into the abdomen just before the wound is closed.

In certain cases of tubal abortion, Prochownick, Martin, and others advocate attempting to save the tube, if possible, by opening it and removing the product of conception, after which it is closed by sutures. Such a procedure may occasionally be advisable if the patient is in good condition, but proof is still lacking that a tube so treated regains its normal functions.

A freshly ruptured tubal pregnancy should not be attacked through the vagina, for the reason that the procedure is often more difficult than a laparotomy, affords but a limited view of the field of operation, while there is always a possibility that it cannot be completed by the vaginal route.

Robb, in 1907, advocated deferring operation while the patient was profoundly shocked, and waiting until the general condition had improved, as he held that the initial hæmorrhage was rarely fatal. The subject was discussed in detail at the meeting of the American Gynecological Society the following year, when the majority of speakers expressed a contrary opinion.

If the patient is not seen until the acute symptoms have subsided and the effused blood has become encapsulated as an hæmatocele, she should be put to bed and carefully watched, operative procedures being instituted only when the hæmatocele steadily increases in size or presents symptoms



indicative of suppuration. This condition, however, rarely presents itself, and Thorn operated upon only 6 out of 157 such cases. When, however, the occasion demands it, excellent results are obtained by evacuating the hæmatocele through an incision in the vaginal fornix and packing the cavity with sterile gauze, as has been recommended by Kelly, Segond, and others. Broad-ligament hæmatomata should be treated in a similar manner.

In the later months the treatment of extra-uterine pregnancy differs markedly according as the fœtus is alive or dead. In very rare cases a living fœtus may be inclosed in an unruptured tubal or ovarian sac, or lie between the layers of the unfolded broad ligament. More frequently, however, one has to deal with a secondary abdominal pregnancy, with the child lying in the peritoneal cavity and inclosed in a sac composed of the fœtal membranes and newly formed adhesions, the placenta being within the tube or broadly implanted upon the floor of the pelvis. Whatever the anatomical conditions, the mother is constantly exposed to the possibility of sudden and acute hæmorrhage so long as pregnancy continues, and accordingly prompt laparotomy is the only conservative method of treatment.

When the child has nearly attained the period of viability, certain authorities urge the propriety of deferring the operation for a few weeks in its interests. While such a course is inadvisable, it may be permissible in exceptional cases, provided the increased dangers of waiting are carefully explained to the patient and her family and accepted by them.

In a small number of cases the operation is comparatively easy and the fœtal sac can be removed as readily as a large ovarian cyst. More frequently, however, the sac is markedly adherent to surrounding organs, or the placental attachment is spread over a broad area, thereby markedly increasing the difficulty of the operation.

Now and again, in broad-ligament pregnancies it will be found that the portion of the broad ligament immediately adjoining the uterus has not been spread apart by the growing ovum, and under such circumstances the entire sac may be removed without great difficulty by ligating the vessels at the pelvic brim and at the uterine cornu before attempting its enucleation.

As a rule, however, the complete removal of the gestation sac is by no means easy, and can only be effected by removing the uterus as well. When, as occasionally happens, it is apparent that the operation cannot be completed without markedly endangering the life of the patient, the sac should be incised, the placenta being avoided, if possible, and the fœtus extracted. The margins of the sac are then stitched to the abdominal incision, the umbilical cord is cut off short, and the cavity packed with sterile gauze, the placenta being left *in situ* and afterward allowed to come away piecemeal. This method necessarily entails a prolonged convalescence, but is much safer than any attempt at removal of the placenta. Occasionally, however, partial separation of the placenta gives rise to such profuse hæmorrhage that its removal must be effected at any cost in the hope of preventing immediate death.

The results following laparotomy in advanced cases of extra-uterine



pregnancy with a living child have improved markedly since the introduction of aseptic methods. This was clearly shown by Harris, who collected 27 such cases in 1887, and 145 additional cases ten years later, with a mortality of 93 and 31 per cent. respectively. Nevertheless, the operation is still one of the most dangerous which the gynaecologist is called upon to perform.

When the foetus is dead the conditions are much more favorable, as the dangers incident to bleeding from the placental site are markedly diminished. For this reason, the operation should be deferred for six or eight weeks after foetal death in order to permit the obliteration of the maternal blood spaces in the placenta, and thus render possible its removal without hæmorrhage. In such cases, however, should dangerous symptoms supervene, immediate interference is indicated. On the other hand, the operation should not be deferred too long, as there is always a possibility that the foetal sac may become infected from the intestinal tract, when a fatal peritonitis may result. Lusk, in 1886, made an earnest plea for prompt operation in such cases, and supported his contention by a long array of statistics.

In a small number of cases of advanced extra-uterine pregnancy operation through the vagina has been recommended. This method of procedure, however, has a very limited field, and laparotomy is usually the operation of choice.

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## SECTION VII

### *PATHOLOGY OF LABOR*

#### CHAPTER XXXI

##### DYSTOCIA DUE TO ANOMALIES OF THE EXPULSIVE FORCES

*Dystocia* or *difficult labor* may be due to various causes, and is most commonly encountered in the following groups of cases: (1) Those in which the expulsive forces are subnormal and are not sufficiently strong to overcome the natural resistance offered to the birth of the child by the bony canal and the maternal soft parts. (2) Those in which, although the expulsive forces may be of normal strength, abnormalities in the structure or character of the birth canal offer an insuperable mechanical obstacle to the descent of the presenting part. (3) Those in which the fœtus, on account of faulty presentation or excessive development, cannot be extruded by the *vis a tergo*. (4) Those cases in which accidental complications, such as eclampsia, hæmorrhage, or rupture of the uterus, lead to various irregularities which interfere with the normal progress of labor.

The expulsion of the fœtus is brought about by the contractions of the uterus, reënforced during the second stage of labor by the action of the muscles of the abdominal wall. Either of these factors may be lacking in force or intensity, while occasionally they may be abnormally strong.

Unfortunately, there is no absolute standard by which the character of the labor pains can be gaged. Thus, in many multiparous women a rapid and happy termination of labor may follow a few relatively slight pains, which in primiparæ would prove quite inadequate to bring about the desired result. Clinically the efficiency of the uterine contractions may be measured by their effect upon the course and duration of labor, provided there is no serious mechanical obstacle to be overcome, so that, other things being equal, prolonged or precipitate labor occurs as a result of abnormalities in their frequency and intensity.

**Prolonged Labor.**—Normally, in the early stages of labor, the uterine contractions occur at infrequent intervals, and gradually increase in frequency, intensity, and duration as its termination is approached. Moreover, a proper alternation between the contraction and relaxation of the uterus is a very important requisite for the successful accomplishment of delivery.



Anomalies are often noted in the first stage of labor. In many instances the pains recur at long intervals and are so feeble in character that dilatation of the cervix is unduly prolonged, with the result that labor, instead of being terminated within the usual period, may drag on for days. If the membranes are unruptured and the patient is in good condition, the delay may be regarded with equanimity, since in the great majority of instances the pains eventually become stronger and more frequent, when the birth of the child is effected without interference. For this reason, the obstetrician should not interfere too hastily, but should encourage the patient to bear her suffering patiently by a plain statement of the facts of the case, and the assurance that a favorable outcome may be expected, not only for her but also for the child.

Again, labor sometimes begins in a perfectly typical manner and gives every promise of an ordinarily speedy termination, and yet after a certain lapse of time, without any appreciable cause, the pains become less frequent and less intense, although giving rise to quite as much or even more suffering than previously. At the same time, the cervix, which was becoming obliterated and dilated in a satisfactory manner, ceases to make further progress, and labor apparently comes to a standstill. The former condition is attributed to primary, and the latter to secondary inertia uteri. In other instances, the contractions, although recurring at frequent intervals, are very painful and cramp-like in character, but exert very little influence upon the dilatation of the cervix. As a result, obliteration of its canal is brought about very slowly, and the external os undergoes but little change. As a rule, such conditions do not give rise to serious complications, since under appropriate treatment the pains assume a more normal character, after which the termination of labor is speedily accomplished.

In all of these conditions the prolongation of labor is commonly attributed to the imperfect dilatation of the cervix, which is supposed to be due to an abnormal rigidity of its tissues. Ordinarily, however, the converse is true, as the condition is the direct result of faulty uterine contractions. That this latter view is correct is shown by the fact that the appearance of satisfactory contractions is promptly followed by rapid dilatation of the cervix and a happy termination of labor. On the other hand, however, especially in primiparæ of thirty years of age or over, excessive rigidity of the cervix and its consequent tardy and imperfect dilatation may be the essential factor in the production of the dystocia, especially when a further complication has been introduced by the premature rupture of the membranes.

Both in primiparous and multiparous women this accident may occur before the onset of uterine contractions, and gives rise to what is designated as "*dry labor*," which is usually unduly prolonged and very painful. The delay is due in great part to the absence of the hydrostatic action of the bag of waters, in consequence of which the changes in the cervix must be brought about almost entirely by the direct pressure of the presenting part, which acts as a dilating wedge of imperfect shape and consistency. This complication is usually not so serious in multiparous as in primiparous women, since in the former labor, as a rule, sets in within 24 hours



after the discharge of the liquor amnii. Occasionally, however, days, and in rare instances even weeks, may elapse before it occurs, so that it is unwise to make a definite prediction as to when labor will supervene.

Not uncommonly obliteration of the cervical canal takes place without difficulty, while the external os alone appears to offer the obstacle to dilatation. In such cases its margins are often extremely thin and sharp, and during a contraction may not exceed a sheet of paper in thickness. On the other hand, especially when labor is unduly prolonged, they may become thick and cedematous.

In the absence of any mechanical obstacle, prolongation of the second stage of labor is rarely due to abnormalities in the uterine contractions, but rather to deficient action of the abdominal muscles. In primiparous women, especially, the tardy labor is often ascribed to the resistance offered by a rigid perineum and a small vaginal outlet, but in the majority of cases this is only apparent, the delay being really due to an insufficient *vis a tergo*.

*Etiology.*—Uterine insufficiency is usually attributed to one of three causes: faulty development or diseased conditions of the uterine musculature, anomalies in its innervation, or mechanical interference with its contraction. The first factor is the one most frequently concerned in the causation of tardy labor, and is especially likely to be associated with imperfect general development, being frequently observed in patients presenting varieties of the justo-minor pelvis, but only rarely in sufferers from rachitic deformities. It should, however, be remembered that faulty development of the musculature is occasionally noted in apparently normal women, and is relatively common in large, pale, and corpulent individuals.

Sometimes the faulty action of the uterine muscle is attributable to a loss of tonicity incident to excessive distention, and is therefore frequently met with in women who have passed through a number of pregnancies in rapid succession, or in whom the uterus has been subjected to acute distention, as in certain cases of multiple pregnancy and hydramnios. Much less commonly the defect is due to general weakness following exhausting diseases, but that this is rarely responsible is shown by the common observation that the pains are usually very efficient even in patients suffering from advanced stages of tuberculosis.

Although direct proof of the existence of abnormalities in the innervation of the uterine musculature cannot be adduced, clinical observation affords strong presumptive evidence in favor of this view, or at least indicates clearly that extraneous causes may interfere reflexly with the activity of the uterus. Thus, it is a matter of common experience that the entrance of the obstetrician into the lying-in chamber is frequently followed by a temporary cessation of the labor pains. Moreover, extreme nervousness, profound mental emotions, or excruciating pain may have a similar effect. In such cases, the severe pain is often due to the irregular action of the uterus, which in turn, by acting reflexly, interferes still further with its function, thus giving rise to a vicious circle. That reflex nervous influences are frequently responsible is shown by the fact that the adminis-



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tration of a sedative may be followed by a return of satisfactory contractions.

That the action of the uterus is occasionally influenced by mechanical conditions is shown by the frequent association of unsatisfactory contractions with the presence of multiple myomata in the uterine wall. Much the same effect is exerted by uterine displacements, especially when the organ sags markedly forward in a pendulous abdomen. Old adhesions about the uterus and appendages and fresh inflammatory areas in the same location may act in a similar manner.

Defective abdominal contractions may be due to a number of causes. Sometimes the insufficiency results from faulty development of the muscles themselves, but more frequently is due to a loss of muscular tone following excessive distention, so that it is much more common in multiparous than in primiparous women. In many instances the insufficiency is only apparent, and is due to the fact that for fear of increased pain the patient is unwilling to bring her abdominal muscles into full play, and accordingly makes voluntary efforts to restrain them. For this reason the obstetrician is often obliged to terminate labor by means of low forceps, although he feels sure that a few minutes' effective use of the abdominal muscles would lead to spontaneous delivery. In many such cases the administration of chloroform is attended by most happy results, since it dulls the sensation of pain sufficiently to enable the patient to bring her abdominal muscles into action.

*Treatment of Prolonged Labor.*—Active treatment is rarely demanded when the tardy labor is the result of infrequent pains of slight intensity, as they gradually become more severe and eventually bring about a spontaneous delivery. It is highly important that the physician should remember that the gravity of a case of labor is not measured by its duration alone, and that interference is not indicated unless objective signs of exhaustion become manifest. If the condition lasts for several days it is important that the patient should sleep well at night, and the administration of hypnotics, or even of morphine hypodermically, is indicated.

On the other hand, when the pains are inefficient, cramp-like, and follow one another in rapid succession without exerting any appreciable effect upon the dilatation of the cervix, excellent results often follow the administration of a hypodermic injection of morphine (grain  $\frac{1}{4}$ ), combined with the sulphate of atropine (grain 1-150); or of a rectal injection containing 30 grains of chloral hydrate in 4 ounces of warm milk, and repeated, if necessary, in one hour.

When the dystocia is due to secondary uterine inertia the problem is more difficult; though, as a rule, if the patient can obtain several hours of sound sleep, more satisfactory pains will appear when she awakens. For this reason the use of a hypnotic is often indicated. In other cases, the administration of 15 grams of quinine sulphate, in solution or in freshly prepared capsules, is promptly followed by a marked increase in the frequency and efficiency of the uterine contractions. If, however, the uterus does not respond to that amount of the drug, its further administration may be regarded as useless.

Following the discovery by Dale that the administration of an extract of the infundibular portion of the hypophysis stimulated the uterine contractions, Hofbauer, in 1911, advocated its employment in uterine inertia. Since then a considerable literature has accumulated upon the subject, and the contributions of Parisot and Spire, Fischer, and others indicate that the hypodermic injection of 1 to 1.5 cubic centimeters of Parke, Davis & Co.'s "pituitrin," repeated a second time, if necessary, frequently leads to a marked improvement in the activity of the uterus. My own experience has not been so satisfactory, but, in view of the favorable reports of others, its employment is justifiable in appropriate cases.

Ergot was formerly used with a free hand in this condition, but the practice cannot be too strongly reprehended. It is true that its administration may be followed by an increase in the intensity of the uterine contractions, but experience has shown that they soon lose their normal characteristics and become tetanic. As a result the uterus is liable to remain firmly contracted upon its contents, and, no longer alternating between contraction and relaxation, loses its expulsive power, so that the final action of the drug is to defeat the very purpose for which it was given. Moreover, if the existence of a mechanical obstacle has been overlooked, the use of ergot may lead to so pronounced an overstretching of the lower uterine segment that rupture occurs. Accordingly, ergot should never be employed for its oxytocic properties, but should be used only as a prophylactic against uterine hæmorrhage after the expulsion of the placenta.

As has already been pointed out, abnormalities in the contraction of the uterus are usually associated with imperfect dilatation of the cervix, and in elderly primiparæ, and occasionally in younger women who have suffered from inflammatory conditions about the cervix, rigidity of the tissues can sometimes be invoked as its underlying cause. In many cases the administration of a sedative is followed by satisfactory results. The use of an anæsthetic, although it sometimes leads to satisfactory dilatation of the cervix, is generally inadvisable, inasmuch as the patient, having once experienced its soothing effect, refuses to dispense with it, so that the obstetrician will often be obliged to continue its employment, with the result that the uterine contractions become less frequent and efficient, and render operative interference necessary. Occasionally a hot full bath is attended by satisfactory results.

In other cases, if the objective condition of the patient indicates the necessity for interference, the introduction into the uterus of a small Champetier de Ribes rubber bag acts as an efficient uterine irritant, and brings about complete dilatation. As a rule, however, if the prompt termination of labor is indicated, dilatation of the cervix should be effected by Harris's manual method, provided the internal os and cervical canal are already obliterated. This procedure, however, should be resorted to only in the presence of some pressing indication, and should not be attempted merely for the sake of shortening the labor. That such a warning is necessary is shown by the fact that each year I see in consultation several women who die from hæmorrhage or infection following deep cervical tears, which have resulted from unnecessary or too hasty interference. Should it appear



that manual dilatation cannot be safely effected, vaginal hysterotomy may be employed with advantage, as recommended by Seitz.

When labor is complicated by premature rupture of the membranes, the patient should be informed concerning its probable effect, and should be encouraged to bear her sufferings as patiently as possible. At the same time she should be most carefully watched, and care should be taken that the child's head is not subjected for too long a time to injurious pressure. Moreover, the premature opening up of the amnion greatly increases the danger of intrapartum infection. This complication may be due to contact infection, or to bacteria making their way up from the external genitalia by means of the capillary layer of fluid extending from the interior of the uterus, and should be guarded against by the strictest observance of asepsis. Infection of the amniotic fluid is not only serious for the mother, but according to the researches of Hellendall may also lead to the death of the child, as the bacteria contained in the amniotic fluid gain access to the mouth and give rise to a general infection or a broncho-pneumonia, which may end fatally a few days after birth.

Accordingly, if objective symptoms of exhaustion exist, and it appears that the mother or child will suffer from further delay, interference is indicated, particularly if the temperature becomes elevated, or changes in the foetal pulse-rate, the passage of meconium, or a markedly oedematous condition of the cervix be noted. In such circumstances dilatation may be effected by means of the rubber bag or manually, or vaginal hysterotomy may be performed, after which delivery should be brought about by the most conservative method available. Forceps, however, should never be applied until the cervix is completely dilated, nor while the head is freely movable above the superior strait.

Tardy labor, due to the prolongation of the second stage, is best treated by the application of forceps, except in those cases in which there is some mechanical obstacle. Occasionally when the patient refuses to use her abdominal muscles, the necessity for instrumental delivery may be obviated by the judicious administration of chloroform.

**Precipitate Labor.**—In certain multiparous women precipitate labor may result from an abnormally slight degree of resistance offered by the soft parts, or from abnormally strong uterine and abdominal contractions, or very occasionally from the absence of painful sensations during the uterine contractions.

Generally speaking, precipitate labor is not attended by serious consequences, although the child is sometimes extruded so rapidly that the patient is unable to secure proper attention. In such circumstances deep tears of the perineum are common. It sometimes happens that the woman is suddenly overtaken by intense labor pains and gives birth to the child before she can reach her bed. In such cases, the child sometimes falls to the ground and sustains severe or even fatal injuries. Occasionally the cord is torn through and the child may bleed to death before aid is obtainable.

If tempestuous pains come on while the patient is under the observation of a physician, they should be controlled by the administration of chloro-



form, in order that the head may be held back and prevented from being born too brusquely. The effects of precipitate labor have been studied particularly by Winckel.

**Tetanic Contraction of the Uterus.**—Occasionally in the first, and more frequently in the second stage of labor, the uterus may cease to relax at regular intervals, and remain in a condition of continued or tetanic contraction. This condition is usually encountered in prolonged labors, in which a mechanical obstacle is opposed to the passage of the child. In such cases the danger of rupture of the uterus becomes imminent, although now and again this accident may occur when everything seems to be going on normally.

So long as the tetanic condition persists, the extrusion of the contents of the uterus is out of the question; while at the same time the patient suffers intense pain, and the child is exposed to considerable danger, owing to interference with the placental circulation. If the condition is not due to an obstruction, it can be temporarily controlled by the administration of sedatives or an anæsthetic, after which delivery should be effected as soon as practicable.

**Contraction of Bandl's Ring.**—Closely related to this form of dystocia is that which is sometimes attributed to a stricture resulting from tonic contraction of *Bandl's ring*. Considerable attention has been directed to this complication within the last few years, and numerous cases have been described by Budin, Demelin, Cheron, Rossa, Dickinson, and others. The French observers believe that, while the portions of the uterus above and below it remain flaccid, Bandl's ring can undergo isolated contraction, and thereby so strongly compress the neck or some other portion of the child as to interfere seriously with its delivery. Cheron has reported instances of transverse presentation in which this kind of stricture developed and confined the child to the upper portion of the uterus, at the same time offering an almost insuperable obstacle to the introduction of the hand for the performance of version.

Veit is probably correct in denying the existence of such conditions in head presentations, and in believing that the reports are due to faulty observation. That the contraction should be confined to Bandl's ring would appear highly improbable, and it is much more likely that the entire active portion of the uterus may pass into a condition of tetanic rigidity, and that under such circumstances its lower margin would be felt as a contracted ring. In such cases the lower uterine segment would be flabby, while the upper portion of the uterus would be tightly contracted, thereby opposing a serious obstacle to the expulsion of the child and to the introduction of the hand or instruments into the uterus. In cases of this character the administration of an anæsthetic relaxes the spasmodic contraction, and delivery can then be accomplished by the most appropriate procedure.

It is likewise probable that, in a certain number of cases in which the dystocia has been attributed to the contraction of Bandl's ring, the condition was really due to more or less rigidity of the internal os, while the cervical canal below it had undergone satisfactory dilatation.

**Hour-glass Contraction.**—As the result of the misuse of ergot, or of



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extensive adherence of the placenta, the uterus sometimes undergoes such an extreme degree of retraction during the third stage that the latter becomes imprisoned in its cavity. In such cases the greater part of the upper segment of the uterus is tightly contracted over the retained placenta, while its lower portion is felt by the examining finger as a tightly contracted ring below the placenta. The lower uterine segment and the cervix, not having recovered from the distention to which they have been subjected, are flabby in character, and widen from above downward to the vaginal insertion. From the shape thus imparted to the uterus the condition is generally designated as an "*hour-glass contraction*." Its occurrence usually necessitates the manual removal of the placenta, which can sometimes be accomplished only under anaesthesia.

**Missed Labor.**—In very exceptional instances uterine contractions come on at or near term, and, after continuing for a variable time, disappear without leading to the birth of the child. The latter then dies, and may be retained *in utero* for months, undergoing mummification or putrefaction, according as the membranes have ruptured or not. This is known as missed labor. The term should not be applied to those cases in which a living child is born, as they are probably only examples of prolonged gestation.

In the cases described by Menzies and Hennig the child had been retained for two hundred and eighty and two hundred and ten days respectively after full term. In the former instance it was removed at autopsy, and in the latter after incision through the cervix. Krevet has recorded a typical case, in which the foetus, which had been retained for sixty-two days, was expelled spontaneously in a partially mummified condition, while the placenta looked as if it had been preserved in a hardening fluid.

Nothing is known as to the aetiology of the condition, though in the cases reported by Labhardt it was associated with carcinoma of the cervix and myoma of the uterus respectively. Cuilla is inclined to associate the phenomenon with excessive fatty degeneration of the uterine musculature. It may readily be confounded with the retention of the child after the false labor following full-term tubal gestation, or with pregnancy in a rudimentary horn of the uterus, though a careful examination should preclude the possibility of such a mistake.

Labor should be induced as soon as the diagnosis is made, and was readily accomplished by the introduction of a bougie in one of my patients two months after the death of the foetus.

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## CHAPTER XXXII

### DYSTOCIA DUE TO ABNORMALITIES OF THE GENERATIVE TRACT

**Vulva.**—Complete atresia of the vulva or the lower portion of the vagina is usually congenital, and unless corrected by operative measures would oppose an insuperable obstacle to conception. Von Meer has reported an exceptional case in which the lower two-thirds of the vagina were lacking, while the upper third communicated with the bladder. Coitus was accomplished *per urethram*, through which a three months' fœtus was subsequently expelled.

More frequently vulval atresia is incomplete, and is due to adhesions and cicatricial changes resulting from injury or inflammatory processes. The defect may offer a considerable obstacle to labor, but the resistance is usually overcome by the continued pressure exerted by the head, though frequently only at the expense of deep perineal tears.

Many cases are on record in which an almost imperforate hymen has remained intact until the time of labor, and only ruptured when distended by the child's head. In rare instances, as was pointed out by Coester, a thick septate hymen may form a bridge of tissue opposing the advance of the presenting part, and may require to be cut through before delivery can be completed.

In some women, especially in elderly primiparæ, the vulval outlet is very small, rigid, and altogether lacking in elasticity. Again, as the result of pressure or renal lesions, the vulva may become so œdematous that its orifice is almost occluded. The latter condition does not necessarily give rise to dystocia, but in both the brittleness of the soft parts predisposes to perineal laceration. Moreover, when the œdema has been excessive, and has persisted for some time, the tone of the tissues may be so lowered that they even become gangrenous as a result of the traumatism incident to labor.

The formation of thrombi or hæmatomata about the vulva, although more common during the puerperium, occasionally occurs during the latter part of pregnancy or at the time of labor, and may give rise to slight dystocia. Inflammatory lesions about the vulva, as well as malignant new growths, may have a similar effect.

**Vagina.**—Complete vaginal *atresia* is nearly always congenital in origin, and is an effectual bar to pregnancy. Incomplete forms, on the other hand, are sometimes manifestations of faulty development, but more frequently result from accidental complications.

Very occasionally the vagina is divided into two halves by a longitudinal septum extending from the vulva to the cervix; more often the structure is

incomplete, being limited to either the upper or lower portion of the canal. Such conditions are frequently associated with abnormalities in the development of the generative tract, and their detection should always lead to further careful examination, with a view to determining whether the uterus and appendages are normal.

A complete longitudinal septum rarely gives rise to dystocia, as the half of the vagina through which the child descends gradually undergoes satisfactory dilatation. On the other hand, an incomplete septum occasionally interferes with the descent of the head, becoming stretched over it as a fleshy band of varying thickness. Such structures are usually torn through spontaneously, but occasionally are so resistant that they must be severed by the obstetrician.

Occasionally the vagina may be obstructed by ring-like strictures or bands of congenital origin. These, however, rarely offer a serious obstacle to labor, as they usually yield before the oncoming head, though in extreme cases incision may be necessary.

Sometimes the upper portion of the vagina is separated from the remainder of the canal by a diaphragm-like structure with a small central opening. Such a condition is occasionally mistaken by inexperienced observers for the vaginal fornix, and at the time of labor for the undilated external os. A careful examination, however, should reveal the presence of the opening, through which a finger can be passed, the cervix then being distinguished above it. After the external os is completely dilated, the head impinges upon the abnormal structure and causes it to bulge downward. If it does not yield, slight pressure upon its opening will usually lead to further dilatation; but if this is not effectual crucial incisions may be necessary in order to allow of delivery.

*Accidental atresia* is always secondary in origin, and results from the formation of adhesions following injuries or inflammatory processes. It sometimes follows severe puerperal infections, during the course of which the entire lining of the vagina may have sloughed off, so that as healing occurs its lumen has become almost entirely obliterated. A similar result is sometimes noted after diphtheria, small-pox, cholera, and syphilis; while in rare instances, as in a case reported by Schenk, it may be due to the action of corrosive fluids injected into the vagina in the hope of inducing abortion. That the most frequent cause of atresia is injury or inflammatory conditions following labor is shown by the fact that 209 of the 1,000 cases collected by Neugebauer presented such a history.

The effects of such conditions vary greatly. In the majority of cases, owing to the softening of the tissues incident to pregnancy, the obstruction is gradually overcome by the pressure exerted by the presenting part; less often manual or hydrostatic dilatation or incisions may become necessary; while in very rare cases extreme dystocia may demand Cæsarean section. Full literature concerning this complication is to be found in the articles of Ward and Brindeau.

Among the rare causes of serious dystocia, *vaginal neoplasms* are worthy of mention, Güder, in 1893, having collected 60 cases from the literature. The obstruction was due to the presence of cystic structures, fibromata, car-



cinomata, sarcomata, or hæmatomata, arising from the vaginal walls or the surrounding tissues. When the tumor is accessible it is best treated by excision, no matter what its origin. If this is not practicable, and the growth is cystic, tapping becomes the operation of choice. The presence of a solid tumor may occasionally afford an indication for Cæsarean section. Sasonoff observed a case in which a vaginal hæmatoma developed so rapidly after the birth of one twin as to interfere seriously with the delivery of the second child.

Exceptionally *tetanic contraction of the levator ani muscle* may seriously interfere with the descent of the head. In this condition, which is analogous to the vaginismus of non-pregnant women, a thick, ring-like structure completely encircles and markedly constricts the vagina several centimeters above the vulva. Hue, in 1906, collected a number of such cases.

Ordinarily the condition yields to the administration of sedatives or anæsthetics, though in one of my patients the obstruction persisted in spite of profound anæsthesia, and it was only after steady pressure had been exerted upon it for some minutes that it relaxed sufficiently to permit the passage of the hand folded in the shape of a cone.

**Cervix.**—Inasmuch as complete atresia of the cervix is incompatible with conception, it must be assumed, whenever such a condition is met with in a pregnant woman, that conception had occurred before its formation. In the majority of cases, however, the atresia is only apparent, and is simulated by a very minute external os.

A good illustration is afforded by the so-called *conglutinatio orificii externi*. In this condition the cervical canal undergoes complete obliteration at the time of labor, while the os remains extremely small with very thin margins, the presenting part being separated from the vagina only by a very thin layer of tissue. Formerly, this appearance was attributed to the existence of adhesions between the lips of the external os, but Schroeder was probably right in stating that it is simply due to a very small and resistant opening. Ordinarily, complete dilatation promptly follows from pressure with a finger tip, though in rare instances manual dilatation or crucial incisions may become necessary.

*Cicatricial stenosis* of the cervix frequently follows difficult labor associated with considerable destruction of tissue. Less frequently it is due to syphilitic ulceration and induration, several instances of which have been reported by Le Bigot. Now and again it results from the employment of corrosive substances for the purpose of producing abortion.

Ordinarily, owing to the softening and succulence of the tissues incident to pregnancy, the stenosis, whatever its cause, gradually yields to the natural forces; but in other cases dilatation has to be accomplished by manual methods or by the employment of rubber bags. In rare instances, however, the resistance may be too great to be so overcome, and in such cases Cæsarean section should be performed early in labor, for, if it be deferred, the lower uterine segment may become stretched to such a degree that rupture becomes imminent.

In two of my patients Cæsarean section was necessary on account of complete atresia of the external os. As spontaneous labor had occurred



previously, and as no history of inflammatory trouble or of attempts at abortion could be elicited, the cause of the condition could not be ascertained. Ahlström, in 1904, reported a somewhat similar case, and thoroughly reviewed the literature.

*Rigidity of Cervix.*—Reference has already been made to the unyielding cervix of elderly primiparæ. Occasionally still greater rigidity is encountered in patients who have suffered from inflammatory lesions, though such conditions rarely give rise to serious dystocia. On the other hand, in certain extreme cases of hypertrophic elongation of the cervix, spontaneous dilatation does not occur, although, as a rule, one is surprised to see how completely the abnormality may be effaced during the course of pregnancy.

**Uterine Displacements.**—*Anteflexion.*—Marked anteflexion of the uterus is usually associated with a pendulous abdomen. In primiparæ the condition is usually indicative of disproportion between the size of the head and the pelvis; whereas in multiparæ it is more often an accompaniment of the flaccidity of the abdominal walls incident to repeated childbearing. In the latter class of cases the abnormal position of the uterus prevents the force of its contractions from being properly transmitted to the cervix, hence the dilatation of the latter is interfered with. Marked improvement in this respect usually follows the maintenance of the uterus in an approximately normal position by means of a properly fitting abdominal bandage.

*Retroflexion.*—As was said in Chapter XXVII, retroflexion of the pregnant uterus is usually incompatible with advanced pregnancy, since, if spontaneous or artificial reposition does not occur, the patient either aborts or presents symptoms of incarceration before the end of the fourth month. In the very exceptional instances in which pregnancy goes on to term the fundus remains attached to the floor of the pelvis, while the anterior wall hypertrophies to such an extent as to afford room for the product of conception. In this condition, which is known as *sacculation*, the head of the child occupies the fundus, while the cervix is sharply bent and so drawn up that the external os lies above the upper margin of the symphysis pubis. At the time of labor the contractions tend to force the child through the most dependent portion of the uterus, while the cervix dilates only partially, so that spontaneous labor is out of the question, and rupture of the uterus may occur, as in a case reported by Campbell. As a rule, the cervix can be dilated manually under anæsthesia, and the child delivered by version; but in rare instances it is so inaccessible that Cæsarean section will afford the most conservative method of delivery.

*Dystocia Due to Operations for the Relief of Retroflexion of the Uterus.*—Unfortunately, several of the operations which have been suggested for the relief of retroflexion of the non-pregnant uterus, while rectifying the condition, occasionally give rise to serious dystocia. Until recently it was generally believed that this could only follow *ventro-* or *vaginal fixation* of the uterus, but as the result of my own experience I have been reluctantly forced to admit that it may also exceptionally occur after *suspension*, even when performed by competent operators with the most approved technique. Thus, it may occasionally happen, as the result of infection or some other unknown condition, that the proposed suspension becomes converted into



a fixation, and as a consequence the uterus becomes firmly attached to the anterior abdominal wall by a thick adhesion, which will neither break nor stretch during pregnancy.

In such an event, serious difficulty may arise at the time of labor in one of three ways: Most frequently, as the result of the adhesion, the anterior wall of the uterus is unable to expand, so that the enlargement of the organ is effected solely at the expense of its posterior wall, while the hypertrophied anterior wall is represented by a thick mass of muscle extending from the point of fixation to the cervix, and more or less encroaching upon the superior strait. As the uterus expands, traction is made upon the cervix, which is gradually drawn upward from its normal position, until the external os is on a level with the promontory of the sacrum, and sometimes considerably above it, so that in extreme cases its posterior lip may be opposite the second or third lumbar vertebra. When labor sets in, dilatation of the cervix is effected very imperfectly, since the bag of waters and the presenting part, instead of impinging upon it, are forced down upon the thickened anterior uterine wall. Accordingly, the uterine contractions, no matter how strong they may be, are unable to effect the completion of labor, and, unless suitable operative aid is forthcoming, rupture of the uterus will occur, as in the cases reported by Dickinson and others.

Less frequently, as in the case reported by Lynch, the anterior wall of the uterus does not hypertrophy, and in such cases the dystocia will be due entirely to the upward dislocation of the cervix.

Very exceptionally, as in the case which I reported in 1906, both walls hypertrophy, and, because of the limited space available between the area of fixation and the cervix, the anterior buckles or becomes folded upon itself, instead of forming a thick muscular pad in front of the cervix. In such conditions the lower part of the uterine cavity becomes divided by a crescentic fold, in front of which a sacculation is formed, in which portions of the fœtus may lie, and thus be inaccessible to the operating hand. Moreover, the dystocia is exaggerated by the upward displacement of the cervix, as well as by the fold itself interfering with the engagement of the presenting part.

Andrews, in 1905, collected the histories of 395 cases of pregnancy occurring in women who had been subjected to ventral fixation or suspension. In the 359 patients who went to full term, delivery was effected by Cæsarean section in 20, by forceps in 21 instances, and once by craniotomy. This, however, does not exhaust the untoward effects of the operation, as the uterus ruptured in 3 other cases, and transverse presentations were noted in 10 instances. In December, 1906, I was able to increase still further the list of complications, and collected from the literature 36 cases of Cæsarean section, as well as 2 additional cases of craniotomy. Since that time many more cases have been reported, and the condition is now recognized as one of the definite factors in the production of dystocia.

I have delivered a large number of women after ventro-fixation or suspension, but in only 4 was serious dystocia observed as the result of the operation. In 2 instances Cæsarean section was necessary, in another a most difficult version was performed, while in the fourth case the dead child

was delivered after craniotomy. In one of my cases the dystocia followed ventrofixation by an unknown operator, while in the other 3 it had been preceded by a typical suspension performed by thoroughly competent operators.

In view of such experiences, the question arises whether the performance of these operations is justifiable in women during the childbearing



FIG. 516.—DYSTOCIA FOLLOWING VENTRO-SUSPENSION. SACCULATION OF ANTERIOR UTERINE WALL.  $\times \frac{1}{2}$ .

*Ad.*, adhesion between uterus and anterior abdominal wall; *A.W.*, abdominal wall; *U.W.*, uterine wall; *B.*, bladder; *F.*, folded anterior uterine wall; *P.*, placent.

period. Formerly I held that, while ventrofixation was contra-indicated, suspension was practically devoid of danger from an obstetrical point of view. My own experience, however, shows that I was in error, and that the latter operation may occasionally give rise to most serious obstetrical complications.

Accordingly, I feel that during the childbearing period neither fixation nor suspension should be employed in the treatment of retroflexion of the



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**Cervix.**—Inasmuch as complete atresia of the cervix is incompatible with conception, it must be assumed, whenever such a condition is met with in a pregnant woman, that conception had occurred before its formation. In the majority of cases, however, the atresia is only apparent, and is simulated by a very minute external os.

A good illustration is afforded by the so-called *conglutinatio orificii externi*. In this condition the cervical canal undergoes complete obliteration at the time of labor, while the os remains extremely small with very thin margins, the presenting part being separated from the vagina only by a very thin layer of tissue. Formerly, this appearance was attributed to the existence of adhesions between the lips of the external os, but Schroeder was probably right in stating that it is simply due to a very small and resistant opening. Ordinarily, complete dilatation promptly follows from pressure with a finger tip, though in rare instances manual dilatation or crucial incisions may become necessary.

*Cicatricial stenosis* of the cervix frequently follows difficult labor associated with considerable destruction of tissue. Less frequently it is due to syphilitic ulceration and induration, several instances of which have been reported by Le Bigot. Now and again it results from the employment of corrosive substances for the purpose of producing abortion.

Ordinarily, owing to the softening and succulence of the tissues incident to pregnancy, the stenosis, whatever its cause, gradually yields to the natural forces; but in other cases dilatation has to be accomplished by manual methods or by the employment of rubber bags. In rare instances, however, the resistance may be too great to be so overcome, and in such cases Cæsarean section should be performed early in labor, for, if it be deferred, the lower uterine segment may become stretched to such a degree that rupture becomes imminent.

In two of my patients Cæsarean section was necessary on account of complete atresia of the external os. As spontaneous labor had occurred



previously, and as no history of inflammatory trouble or of attempts at abortion could be elicited, the cause of the condition could not be ascertained. Ahlström, in 1904, reported a somewhat similar case, and thoroughly reviewed the literature.

*Rigidity of Cervix.*—Reference has already been made to the unyielding cervix of elderly primiparæ. Occasionally still greater rigidity is encountered in patients who have suffered from inflammatory lesions, though such conditions rarely give rise to serious dystocia. On the other hand, in certain extreme cases of hypertrophic elongation of the cervix, spontaneous dilatation does not occur, although, as a rule, one is surprised to see how completely the abnormality may be effaced during the course of pregnancy.

**Uterine Displacements.**—*Anteflexion.*—Marked anteflexion of the uterus is usually associated with a pendulous abdomen. In primiparæ the condition is usually indicative of disproportion between the size of the head and the pelvis; whereas in multiparæ it is more often an accompaniment of the flaccidity of the abdominal walls incident to repeated childbearing. In the latter class of cases the abnormal position of the uterus prevents the force of its contractions from being properly transmitted to the cervix, hence the dilatation of the latter is interfered with. Marked improvement in this respect usually follows the maintenance of the uterus in an approximately normal position by means of a properly fitting abdominal bandage.

*Retroflexion.*—As was said in Chapter XXVII, retroflexion of the pregnant uterus is usually incompatible with advanced pregnancy, since, if spontaneous or artificial reposition does not occur, the patient either aborts or presents symptoms of incarceration before the end of the fourth month. In the very exceptional instances in which pregnancy goes on to term the fundus remains attached to the floor of the pelvis, while the anterior wall hypertrophies to such an extent as to afford room for the product of conception. In this condition, which is known as *sacculation*, the head of the child occupies the fundus, while the cervix is sharply bent and so drawn up that the external os lies above the upper margin of the symphysis pubis. At the time of labor the contractions tend to force the child through the most dependent portion of the uterus, while the cervix dilates only partially, so that spontaneous labor is out of the question, and rupture of the uterus may occur, as in a case reported by Campbell. As a rule, the cervix can be dilated manually under anæsthesia, and the child delivered by version; but in rare instances it is so inaccessible that Cæsarean section will afford the most conservative method of delivery.

*Dystocia Due to Operations for the Relief of Retroflexion of the Uterus.*—Unfortunately, several of the operations which have been suggested for the relief of retroflexion of the non-pregnant uterus, while rectifying the condition, occasionally give rise to serious dystocia. Until recently it was generally believed that this could only follow *ventro-* or *vaginal fixation* of the uterus, but as the result of my own experience I have been reluctantly forced to admit that it may also exceptionally occur after *suspension*, even when performed by competent operators with the most approved technique. Thus, it may occasionally happen, as the result of infection or some other unknown condition, that the proposed suspension becomes converted into



plicating pregnancy often remains unsuspected, the condition having been recognized in only 18 of McKerron's first series of cases. Nevertheless, more careful observation should certainly eliminate a large proportion of these errors, as any excessive enlargement of the abdomen or the appearance of pressure symptoms should always lead one to make a careful examination. Again, failure of the presenting part to engage, when the pelvis is known to be normal, suggests an obstructing mass. On the other hand, if the tumor does not occupy the pelvic cavity, the diagnosis is extremely difficult, and the abdominal enlargement is frequently attributed to the presence of twin pregnancy or hydramnios, and the true condition is not recognized until after labor.

Treatment.—If the tumor is detected prior to the last month of pregnancy, it should be removed at once by laparotomy. Orgler has collected 142 such operations, which Heil, in 1904, increased to 188, with a maternal mortality of 2.1 per cent.

It has been objected that such a procedure increases the chances of premature delivery, which occurred in 19.47 per cent. of the cases collected by Orgler and Heil. It should, however, be remembered that a similar accident may take place even if the patient is not interfered with, having been noted in 17 per cent. of Remy's cases. This difference is so slight that the chances for the child are little, if at all, impaired by operation, while those of the mother are markedly improved.

On the other hand, when the diagnosis is not made until the last month of pregnancy, it is usually advisable to postpone the operation until term, for the reason that the fresh abdominal cicatrix is not well adapted to the strain of parturition. At the time of labor, if the tumor is impacted in the pelvis, unanimous opinion favors its immediate removal by laparotomy. Lland Sutton, Spencer, and most authorities advise that the abdomen should then be closed and the birth of the child left to Nature, or at most assisted by forceps. On the other hand, I am of the opinion that a supplementary Cæsarean section should immediately follow, believing that the woman should not be submitted to the strain of labor immediately after a severe operation.

Formerly it was advised to attempt the reposition of the mass under anæsthesia. This practice, however, is not to be recommended, for the reason that the tumor is very liable to give rise to trouble during the puerperium. Moreover, since operative interference will be necessary sooner or later, it would seem far better to institute radical measures without delay. Puncture through the vagina, although strongly advocated at one time, must be considered as a dangerous and extremely reprehensible practice, inasmuch as we possess no means of preventing the tumor contents from contaminating the peritoneal cavity.

If spontaneous labor has occurred, the patient should be carefully watched during the puerperium for the appearance of untoward symptoms. Should they arise, prompt operation is imperatively demanded. In any event, a woman suffering from an ovarian tumor should not be discharged from treatment until the tumor has been removed, or at least until the importance of operative procedures has been strongly urged upon her.

*Tumors of Other Origin.*—Labor is occasionally obstructed by tumors of various origin, which encroach upon the cavity of the pelvis to such an extent as to render delivery difficult or even impossible. In Chapter XXXVIII reference will be made to dystocia due to tumors arising from the pelvic walls.

In rare instances a normal sized or *enlarged kidney* or *spleen* may prolapse into the pelvic cavity and offer an obstacle to labor. Bland Sutton has added an additional case of displaced kidney complicating pregnancy to those collected by Cragin; and has also reported the removal of a prolapsed spleen in the second month of pregnancy, which would have given rise to serious dystocia at the time of labor had it remained *in situ*.

*Echinococcus cysts* are occasionally implanted in the pelvic cavity. Franta, in 1902, collected 22 cases noted during pregnancy and discussed their effect upon the course of labor.

In Chapter XXX reference was made to those cases in which an old extra-uterine gestation sac so obstructed the pelvic canal as to interfere with the delivery of a subsequent intra-uterine pregnancy.

*Enterocoele* or hernia through the vaginal walls occasionally gives rise to dystocia, though in the majority of cases the prolapsed intestine can be replaced and the obstacle temporarily overcome. Where this is not possible, Cæsarean section is indicated as a more conservative procedure than forcibly dragging the child over a large irreducible hernia.

In occasional instances *tumors of the bladder* may likewise offer an impediment to the passage of the child, though it is rarely so serious as to demand operative interference. On the other hand, cases have been reported in which it has been necessary to remove a large calculus from the bladder before delivery could be effected.

A large *rectocoele* or *cystocoele*, though occasionally offering slight obstacle to labor, can generally be replaced while delivery is being effected.

Tumors arising from the lower part of the rectum or pelvic connective tissue may likewise give rise to serious dystocia Holzapfel having collected a series of cases in which *carcinoma of the rectum* rendered Cæsarean section necessary.

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## CHAPTER XXXIII

### CONTRACTED PELVIS

We consider a pelvis contracted when it is so shortened in one or more of its diameters as to affect materially the mechanism of labor, but without necessarily retarding the birth of the child. According to Litzmann, this is the case when the conjugata vera measures 9.5 centimeters or less in flat, and 10 centimeters or less in generally contracted pelvises.

**History.**—Inasmuch as Vesalius was the first to describe the normal pelvis correctly, it is clear that the conception of abnormal forms could not have existed before his time. His pupil, J. C. Arantius (1530-1589), gave the first anatomical description of such a pelvis, but his discovery exerted no appreciable effect upon the obstetrical art of the period, for the reason that Ambroise Paré still held to the old view of the separation of the pubic bones during labor, and promulgated it in his writings.

During the next century knowledge of the subject advanced but slowly, and we find Mauriceau (1637-1709) stating that in his very large experience he had observed only two instances of contracted pelvis. In one of these Chamberlen was permitted to apply the forceps invented by his uncle, but failed to effect a delivery.

We are indebted to Heinrich van Deventer for our first knowledge of contracted pelvises from an obstetrical standpoint. In his "New Light for Midwives," which appeared in 1701, he described the generally contracted and the flat varieties, and discussed the influence which they exert upon labor. From that time on mention of the subject is to be found in all the text-books, De la Motte, Puzos, and Dionis being the obstetricians of the first half of the eighteenth century who devoted most attention to it. The last-named observer was the first to point out the causal relation which rhachitis bears to many cases of pelvic deformity.

Important contributions to the subject were made by Smellie. In his treatise on "The Theory and Practice of Midwifery," published in 1752, is to be found an excellent description of the normal pelvis, as well as of the more usual varieties of deformity to which it is subject. He also laid down practical rules for the estimation of the degree of contraction, carefully described the mechanism of labor in such cases, and gave excellent pictures showing the influence exerted by the contracted pelvis upon the foetal head.

Baudelocque (1746-1810) contributed largely toward the development of our knowledge of the subject, as he devoted particular attention to the

diagnosis of the condition in the living woman, and showed that it could be detected by measuring the distance between certain external bony parts of the pelvis by means of a pair of calipers. He was the first to describe the external conjugate, which is now generally known by his name, and taught that by deducting 3 inches from it the length of the conjugata vera could be readily and accurately estimated.

At the same time G. W. Stein, in Germany, did good work upon somewhat similar lines and devised a pelvimeter for the direct mensuration of the conjugata vera.

The real foundation, however, for our modern doctrine was laid by Michaelis and Litzmann. The former was Professor of Obstetrics in the University of Kiel from 1843 to 1850, and during that time carefully measured the pelvis in 1,000 consecutive cases of labor. He designated as contracted all pelves in which the conjugata vera measured 8.75 centimeters or less, and found 72 such cases in his series, a percentage of 7.2. After his death he was succeeded by Litzmann, who continued the work, and soon reported accurate measurements based upon a second series of 1,000 cases. He advanced the definition which is given at the beginning of the present chapter, and placed the upper limit at a conjugata vera of 10 or 9.5 centimeters, according as the pelvis is generally contracted or flat, respectively. Judged by these criteria he found 14.9 per cent. of abnormal pelves, and estimated that had Michaelis employed the same standard his percentage would have been 13.1.

Litzmann's definition and criteria have been adopted throughout the world, and since the appearance of his work scientific obstetricians have devoted an increasing amount of attention to the subject. To mention all who have added materially to our knowledge would be equivalent to writing the history of obstetrics for the past fifty years; but Naegele, Kilian, Schauta, and Breus and Kolisko may be cited as among the most important contributors.

**Frequency.**—In this country and in England very few statistics are available upon which to base accurate statements as to the frequency of contracted pelves, but in Germany and France many of the large lying-in hospitals supply valuable data. The incidence varies considerably in different countries, and even in various parts of the same country. Thus, as is shown by the following table, it ranges from 8 to 24 per cent. in various German clinics.

|                          |          |               |                 |
|--------------------------|----------|---------------|-----------------|
| Goenner (Basel) .....    | observed | 7.9 per cent. | in 2,433 cases. |
| Heinsius (Breslau) ..... | "        | 8.5           | " " 1,641 "     |
| Pfund (Munich) .....     | "        | 9.5           | " " 1,199 "     |
| Fuchs (Erlangen) .....   | "        | 11.43         | " " 1,766 "     |
| Michaelis (Kiel) .....   | "        | 13.1          | " " 1,000 "     |
| Köttgen (Bonn) .....     | "        | 13.45         | " " 2,000 "     |
| Litzmann (Kiel) .....    | "        | 14.9          | " " 1,000 "     |
| Müller (Berne) .....     | "        | 16            | " " 1,177 "     |
| Weidenmüller (Marburg).. | "        | 18.7          | " " 3,224 "     |
| Baisch (Tübingen) .....  | "        | 24            | " " 3,375 "     |
| Leopold (Dresden) .....  | "        | 24.3          | " " 2,415 "     |



Winckel states that contracted pelves are observed in from 10 to 15 per cent. of all German women, while Schauta estimates that the condition is met with in one woman out of seven. The statistics from the Austrian Empire seem to indicate a lesser frequency than in Germany, as is shown by the following table:

|                                    |      |           |    |        |        |
|------------------------------------|------|-----------|----|--------|--------|
| Ludwig and Savor (Vienna) observed | 3.84 | per cent. | in | 50,621 | cases. |
| Pawlik (Prague) .....              | 7.8  | "         | "  | 29,615 | "      |
| Bürger (Vienna) .....              | 10.4 | "         | "  | 49,397 | "      |

Large series of statistics are not available for France. The yearly reports from Pinard's clinic, however, indicate a frequency of about 5 per cent., while Budin gives 8 per cent. in 7,687 cases, and Tarnier 16 per cent. in 715 cases.

Fancourt Barnes, in 1897, reported that only 0.5 per cent. of contracted pelves were observed in 38,065 cases of labor in London. In view of the fact, however, that every year a considerable number of Cæsarean sections are performed in that city for this indication, it would appear probable that his figures in no way represent the true condition.

It has been a matter of general belief that in this country contracted pelves are very rare, and Dewees stated in 1824 that he had observed only three cases in his large experience. Lusk held a similar opinion, and said that rhachitis is rarely, and osteomalacia never, observed among native American women. Hirst, on the other hand, states that these diseases are not of infrequent occurrence, and that no one who practices obstetrics can fail to meet with occasional examples.

We owe to Reynolds the first statistical statement upon the subject in this country. In 1890 he reported that he had observed 1.34 per cent. of contracted pelves in 2,227 women delivered in Boston. His statements, however, must be accepted with reserve and as underestimating the frequency of the condition; since he measured the pelvis only in those cases which required operative interference, and left out of consideration those in which labor terminated spontaneously. Had he taken these into account he would, in all probability, have reported a frequency of 6.8 per cent. Flint, in 1897, observed 8.46 per cent. of contracted pelves in 10,233 consecutive patients delivered by the Society of the New York Lying-in Hospital.

Since the opening of the lying-in department of the Johns Hopkins Hospital, it has been our rule to measure both externally and internally the pelvis of every pregnant woman coming into our hands. In 1899 I reported that we had met with 131 contracted pelves in the first 1,000 women delivered, and in 1901 recorded an identical percentage in 2,133 women, somewhat over one-half having been delivered by the out-door service.

In April, 1911, I analyzed the conditions found in 4,750 patients treated in the lying-in ward, of whom 3,837 were delivered at full term—2,178 white and 1,659 black. In this series the total incidence of the usual types of contracted pelves was 18.4 per cent., but a pronounced difference

was noted in the two races: 8.49 per cent. in the white, as compared with 32.61 per cent. in the black women.

In the last 2,750 patients—with 2,215 full-term deliveries, 1,313 white and 902 black—I not only made the usual pelvic measurements, but paid particular attention to the dimensions of the inferior strait, and designated as "funnel" all pelves in which the distance between the tubera ischii was reduced to 8 centimeters or less. In this series the usual types of contracted pelvis showed an incidence of 18.33 per cent., and the funnel pelvis one of 6.1 per cent.; the former being observed in 7.46 and 34.5 per cent., and the latter in 5.87 and 6.43 per cent., of the white and black women, respectively.

Accordingly, it would appear that in my service the usual types of contracted pelvis occur four or five times more frequently in black than in white women, while funnel pelves are equally frequent in the two races. In other words, every twelfth to thirteenth white and every third colored woman in Baltimore has a typical contracted pelvis; while, in addition, every sixteenth woman in either race has a funnel pelvis. Hence, it is evident that no one can practice obstetrics without frequently encountering such conditions.

As will be explained in detail later, the preponderance of the usual types of contracted pelvis in colored women is due to the prevalence of rickets, and to the general physical degeneration which seems to overtake members of that race who live long in large cities. That labor is not more disastrous to them is due to the fact that their children are smaller and have softer heads than those of white women, as was demonstrated by my former assistant, T. F. Riggs.

**Methods of Diagnosis.**—It is essential that the obstetrician be able to diagnose the existence and extent of the contraction before the onset of labor, in order that he may, as far as possible, decide in advance upon the proper line of treatment to be instituted in each case. With this in view, accurate pelvic mensuration should constitute an integral part of the preliminary examination of the pregnant woman, and, in the present state of our knowledge, a physician who practices obstetrics without pelvimetry must be regarded as no better than one who treats diseases of the heart and lungs without the aid of auscultation and percussion.

At the *preliminary examination*, which should be made four to six weeks before the expected time of confinement, the physician should neglect no means of obtaining all possible data bearing upon the case. Generally speaking, large, well-built women are likely to have normal, and undersized women contracted pelves; but this rule by no means always holds good, and it is not unusual for examination to disclose some abnormality in the former and perfectly normal pelves in the latter.

The gait of the patient should be carefully noted, since the existence of a limp or some peculiar way in which the feet are placed upon the floor may serve to direct attention to the possibility of a pelvic deformity. Marked abnormalities of the spinal column—kyphosis or lordosis—are also suggestive, and even slight degrees of spinal curvature should not be overlooked, as they are frequently of rhachitic origin. The more usual signs



of rhachitis—deformities of the extremities, the characteristically shaped head, and the rhachitic rosary—should always be looked for. Likewise, inquiry should be made as to the age at which the patient first learned to

walk, and if she is found to have been backward in this respect the possibility of a rhachitic pelvis should be borne in mind, even though the usual external manifestations of the disease may be lacking.

If the patient has already borne children she should be questioned as to the course of previous labors, and the history of any serious difficulty should always suggest the possibility of an abnormal pelvis. On the other hand, a negative history is by no means so valuable, as it is a well known fact that in moderate degrees of pelvic contraction the first labor may be relatively easy, while each successive one becomes more difficult. In primiparous women a markedly pendulous abdomen, or the absence of engagement of the head in the last month of pregnancy, should always be regarded as evidence of the exist-

ence of a marked disproportion between the child's head and the pelvis, until careful examination shows that such is not the case.

*Pelvimetry.*—While the above-mentioned conditions are of value in suggesting the possibility of pelvic deformity, accurate information as to its existence and extent can be obtained only by measuring the pelvis.

For this purpose external and internal pelvimetry are employed, according as the measurements are taken from the surface of the body or through the vagina. As has already been said, Baudelocque was the first to insist upon the importance and value of the former, and invented the first pelvimeter, which consisted of

a pair of calipers or compasses provided with a scale to indicate the extent to which they are opened. Innumerable instruments of this kind have since been devised, but, although most of them give satisfactory results,



FIG. 518.—BUDIN'S PELVIMETER. FIG. 519.—MARTIN'S PELVIMETER.



FIG. 520.—METHOD OF HOLDING PELVIMETER.

before buying one it is always well to see that the blades are sufficiently curved to allow them to span the thighs of stout patients. Thus, Budin's pelvimeter (Fig. 518), which can readily be carried in the pocket, gives satisfactory results in the vast majority of cases; but it cannot be used to measure the external conjugate in stout women, owing to the slight curvature of its blades. Personally, I usually employ the instrument devised by E. Martin (Fig. 519).

(a) *External Pelvimetry*.—The ordinary measurements are four in number: the distance between the anterior superior spines of the ilium,

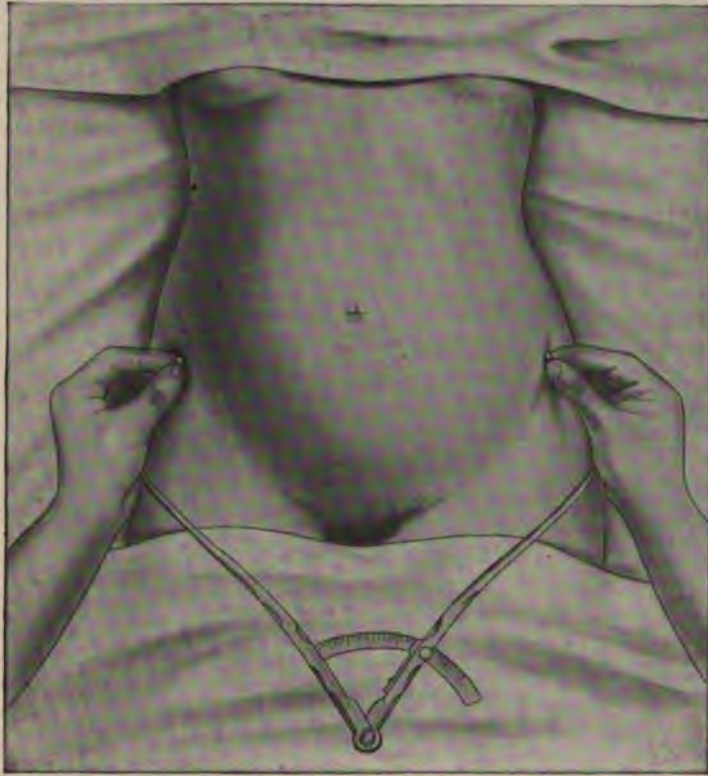


FIG. 521.—MEASURING THE DISTANCE BETWEEN THE ANTERIOR SUPERIOR SPINES.

between the crests of the ilium, between the heads of the trochanters, and between the depression beneath the spinous process of the last lumbar vertebra and the anterior surface of the symphysis pubis. Normally these measure 26, 29, 32, and 21 centimeters respectively. Naegele suggested certain other measurements, which, as a rule, are not employed unless one suspects the existence of an obliquely contracted pelvis.

When the pelvis is to be measured externally, the patient should lie upon a bed or table with her abdomen and hips either bared or covered only by a thin chemise. The legs and upper portions of the body should



not be exposed. In order to make the first three measurements, the physician should sit on the side of the bed facing the patient. He then grasps the tips of the pelvimeter between the thumb and second finger of each hand, and, having located the outer edges of the *anterior superior spines* with the index fingers, presses the tips of the pelvimeter upon them as closely as possible, the distance between them being indicated on the scale of the instrument.

In measuring the distance between the *iliac crests*, the most widely separated portions are located, and the tips of the pelvimeter applied to their



FIG. 522.—MEASURING THE EXTERNAL CONJUGATE.

outer edges. In taking these measurements, it should be borne in mind that the iliac spines and crests present an outer and inner lip and an intermediate ridge, and that the distance between the outer lips is 1.5 to 2.5 centimeters greater than that between the inner lips.

In determining the distance between the *trochanters*, the patient's legs having been brought into close apposition, the examiner carefully palpates the upper portion of the thighs until the most prominent points of the trochanters are felt on either side. The tips of the pelvimeter are then firmly pressed against them, so that they come into the closest possible contact with the bones, after which the measurement is read off on the scale.

The external conjugate, or *Baudelocque's diameter*, extends from the depression just beneath the spine of the last lumbar vertebra to the anterior and upper margin of the symphysis pubis. For this measurement, the woman should lie on her side with her back toward the physician. As a rule, the spine of the last lumbar vertebra is quite prominent, and is readily found by palpating and counting the spinous processes from above downward. Immediately beneath it is a slight depression, which forms the posterior extremity of the diameter to be measured. Into this one tip of the pelvimeter should be inserted and held firmly in place, while the other hand seeks the upper margin of the symphysis pubis, and firmly applies the other tip of the pelvimeter to it. The distance separating them is then read off on the scale.

In stout women considerable difficulty may be experienced in locating the posterior extremity of this diameter, owing to the fact that the spinous process of the last lumbar vertebra cannot be identified. This difficulty can usually be obviated in the following manner: A line is drawn between the depressions marking the attachment of the fascia to the superior posterior spines of the ilium, which are usually clearly visible. A point 2.5 centimeters above the middle of this line will usually correspond to the point required, and will lie at the apex of a four-sided space—Michaelis's rhomboid—whose upper and lower margins are formed by the transverse and sacro-spinalis and gluteus muscles respectively. <sup>x</sup>

*The Value of External Pelvimetry.*—Baudelocque, in describing the external conjugate, stated that by deducting 3 inches from it the length of the true conjugate could be accurately estimated. He based his opinion upon the fact that he had rarely observed a difference of more than 1 or 2 lines between the estimated and the actual conjugata vera in 30 odd cases which he had measured during life and at autopsy. Later experience, however, has shown that these conclusions were erroneous, and that the length of the external conjugate gives a very imperfect idea of that of the conjugata vera, since several modifying factors may exist. Thus, the amount to be deducted varies with the thickness of the sacrum and the symphysis pubis, and also depends, to a great extent, upon the elevation of the promontory of the sacrum and the length of the spinous process of the last lumbar vertebra. Unfortunately, these factors cannot be accurately estimated in the living woman, and Skutsch has shown that in 100 pelves examined by him the difference between the length of the external and of the true conjugate varied from 5.5 to 10 centimeters. Baisset arrived at similar conclusions



FIG. 523.—MICHAELIS'S RHOMBOID (Stratz).



after studying 120 dried pelvises; and I have in my possession two specimens whose true conjugates are of equal length, but whose external conjugates show a difference of 5 centimeters.

Although the measurement of the external conjugate does not give accurate information concerning the length of the conjugata vera, it nevertheless enables us to draw certain important conclusions. Thus, generally speaking, when the former measures between 20 and 21 centimeters, the conjugata vera will rarely be found to be shortened; when, however, it measures between 18 and 19 centimeters, the conjugata vera is shortened in about one-half of the cases; and when it is below 17 centimeters pelvic contraction is almost uniformly present.



FIG. 524.—MEASURING THE DIAGONAL CONJUGATE.

It was formerly believed that one could form a fairly accurate estimate of the length of the transverse diameter of the superior strait by making certain deductions from the distances between the anterior superior spines and between the crests of the ilium. The incorrectness of this conclusion, however, was first demonstrated by Scheffer, who showed that the transverse diameter of the superior strait may be of the same length in two pelvises, while at the same time the distances between the iliac crests vary by as much as 3.3 centimeters. This source of error depends in great part upon the angle which the iliac fossa forms with the rest of the innominate bone, and the extent to which its anterior portion is flared out.

The distance between the trochanters is the least valuable of all the measurements, as its length depends, to a great extent, upon

the angle which the neck of the femur forms with its shaft; and as a consequence its shortening, unless very marked, does not indicate a corresponding decrease in the transverse diameters of the pelvic cavity. Goenner, in 1901, demonstrated that external pelvimetry alone gave a very erroneous idea concerning the existence of contracted pelvis. After measuring the external diameters in 100 cadavers, he compared them with those of the pelvic cavity when measured directly, and found that, whereas the former indicated that nearly all of the pelves were contracted, the latter proved that such was the case in only 22 instances. My own observations bear out his conclusions; as the use of the external measurements alone indicates the presence of contracted pelvis in three-quarters of all colored women, as compared with only one-third as shown by internal pelvimetry.



FIG. 525.—MEASURING THE LENGTH OF DIAGONAL CONJUGATE UPON THE FINGERS.



FIG. 526.

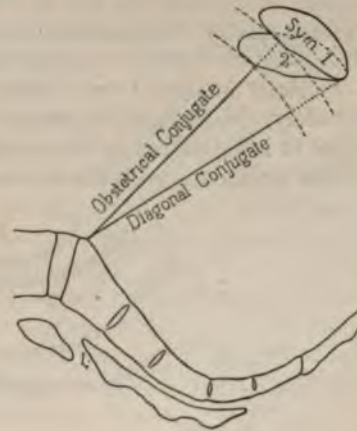


FIG. 527.

FIGS. 526, 527.—DIAGRAMS SHOWING VARIATIONS IN LENGTH OF DIAGONAL CONJUGATE DEPENDENT UPON THE HEIGHT AND INCLINATION OF THE SYMPHYSIS PUBIS.

Nevertheless, despite many possible inaccuracies, the external measurements are of considerable value, in that they serve to indicate with tolerable certainty the variety of pelvis with which one has to deal. Normally the distance between the spines is 2.5 to 3 centimeters less than that between the crests; but in the rachitic pelvis, owing to the flaring of the iliac spines,



this proportion becomes deranged, and the two measurements approximate one another in length, the former frequently being equal to, and occasionally exceeding the latter. If, however, both measurements are considerably below the normal, but preserve their usual relation to one another, and at the same time the external conjugate is also proportionately shortened, it is permissible to conclude that the entire pelvis measures below normal in all its diameters, or, in other words, is generally contracted.

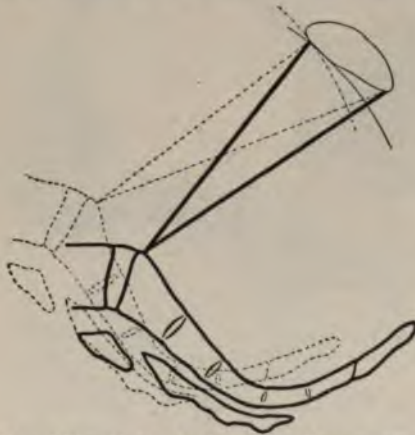


FIG. 528.—DIAGRAM SHOWING EFFECT OF POSITION OF PROMONTORY OF SACRUM UPON THE LENGTH OF THE DIAGONAL CONJUGATE.

In private practice it is my rule to employ external pelvimetry at the preliminary examination four to six weeks before the expected date of confinement. If the measurements are approximately normal, the patient being a primipara and the child's head deeply engaged in the pelvic cavity, internal mensuration is not practiced. But if the external conjugate falls below 18 centimeters, internal pelvimetry should be resorted to, no matter what the position of the head, nor how many children the patient may have borne previously.

(b) *Internal Pelvimetry.*—In the vast majority of abnormal pelvises the most marked deformity affects the antero-posterior diameter of the superior strait, and as a consequence we are especially anxious to ascertain the length of the conjugata vera. Unfortunately, this cannot be measured directly in the living woman, and in practice it is estimated by measuring the diagonal conjugate—the distance from the promontory of the sacrum to the lower margin of the symphysis

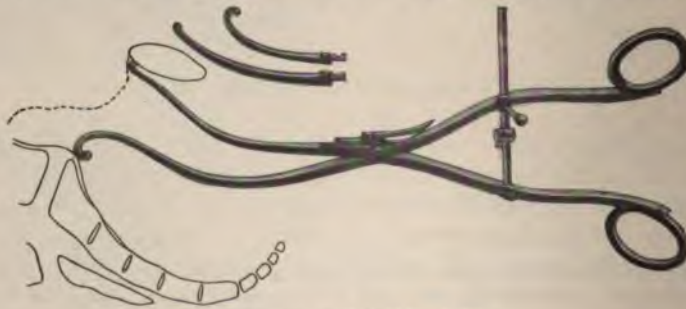


FIG. 529.—STEIN'S PELVIMETER.

pubis—and making a certain deduction from it. This method was introduced by Smellie, and still further elaborated by Baudelocque.

*Measuring the Diagonal Conjugate.*—For this purpose the patient should be placed upon an examining table with her knees drawn up. If this can-

not be conveniently arranged, she should be brought to the edge of the bed and a firm pillow placed beneath her buttocks. Two fingers are introduced into the vagina, and the anterior surface of the sacrum is methodically palpated from below upward, and its vertical and lateral curvature noted.



FIG. 530.—MEASURING CONJUGATA VERA WITH SKUTSCH'S PELVIMETER.

At the same time the mobility of the coccyx should be tested by seizing it between the fingers in the vagina and the thumb externally. In normal pelvis only the last three sacral vertebræ can be felt without pushing up the perineum, whereas in markedly contracted varieties the entire anterior surface of the sacrum is readily accessible.

Ordinarily, in order to measure the diagonal conjugate, the elbow must be depressed and the perineum forcibly pushed upward by the knuckles of the third and fourth fingers, while the index and second fingers are held firmly together and directed upward in the direction of the umbilicus. The promontory of the sacrum is soon felt by the tip of the second finger as a projecting bony margin at the base of the sacrum. With the finger closely applied to its most prominent portion, the hand is elevated until the radial surface of the index finger is brought into close contact with the pubic arch. This point is then marked by the nail of the index finger of the other hand, after which the fingers are withdrawn from the vagina and the distance between it and the tip of the second finger is measured (Figs. 524 and 525). This represents the diagonal conjugate, from which the true conjugate is estimated by deducting 1.5 to 2 centimeters, according to the height and inclination of the symphysis pubis.

In this method the problem consists in estimating the length of one side of a triangle, the conjugata vera; the other two—the diagonal conjugate and the height of the symphysis pubis—being known. Were we able to measure satisfactorily the angle formed between the symphysis and conjugata diagonalis, the exact length of the true conjugate could readily



be ascertained by the ordinary rules of trigonometry. Unfortunately, this cannot be done in the living woman, but for practical purposes it suffices to estimate the length of the diagonal conjugate as just described, deducting 1.5 centimeters from it if the pubis is low and slightly inclined, and 2 centimeters if it is high and has a marked inclination. The rationale of this is clearly shown in Figs. 526 and 527. The length of the diagonal conjugate also varies according to the position of the promontory, being longer when it is elevated, and *vice versa* (Fig. 528). Van der Hoeven (1912) has pointed out the fallacies involved in indirect mensuration, and holds that they are so great as almost to destroy its usefulness.

Since the time of G. W. Stein (1772), numerous instruments have been devised for the purpose of measuring the conjugata vera directly; but unfortunately the majority of them, while theoretically correct, are practically useless on account of the difficulty of their application. Descriptions and illustrations of many of them are to be found in Skutsch's excellent monograph.

Skutsch, in 1886, devised a pelvimeter by which the conjugata vera could be indirectly, though accurately, measured (Fig. 530). Hirst more



FIG. 531.—HIRST'S PELVIMETER.

recently described a simple device for the same purpose. Both of these instruments give fairly satisfactory results when properly used, but their employment is usually so painful to the patient as to require the administration of an anæsthetic. Naturally, therefore, they are employed only when accurate information concerning the length of the conjugata vera is urgently called for, and even then they leave a great deal to be desired.

Neumann and Ehrenfest, in 1900, described a complicated instrument—the *pelvigraph*—by means of which the contour of the anterior and posterior walls of the pelvis can be graphically outlined, whence the exact length of the various antero-posterior diameters can be readily ascertained. This instrument gives excellent results, but is too complicated for use outside of a well-regulated hospital.

Since 1904 renewed interest has been manifested in the direct mensu-

ration of the conjugata vera, and Bylicki, Ahlfeld, Zweifel, Gauss, and others have devised more or less simple instruments for the purpose. In the hands of their inventors such instruments have proven most satisfactory, but others have found that their employment gives no more accurate results than can be obtained by the old manual method; although Van der Hoeven considers that greater accuracy can be obtained by the use of Gauss's instrument than by any other method.

*Measuring the Transverse Diameter of the Superior Strait.*—This diameter cannot be measured directly in the living woman, and, as a rule, for all practical purposes it is necessary only to palpate the linea terminalis with the examining fingers, and in this way roughly estimate the outlines of the superior strait. If, however, we wish to be more exact, its length can be ascertained approximately by the employment of Skutsch's instrument (Fig. 532).

Löhlein attempted to estimate the size of this diameter by adding a "constant" to what he designated as the ascending oblique diameter. This extends from the lower margin of the symphysis pubis to the anterior and upper margin of the sacro-sciatic notch, and can be measured by the finger. As the investigations of Steinbrecher show that the size of the "constant" varies in the several varieties of deformed pelvis, it is apparent that only approximate results can be obtained by this means.

*Contractions of the Pelvic Outlet.*—As has already been indicated, contractions of the pelvic outlet occur in 5 or 6 per cent. of all women, and probably represent the most usual type of abnormality encountered in the white women of this country, and, as they may give rise to serious dystocia, should receive more extended consideration than they are usually accorded. The contraction may be limited to either the transverse or the antero-posterior diameter, or may involve the two, and be either symmetrical or irregular in character. Leaving out of consideration the cases associated with kyphotic, osteomalacic, obliquely contracted, and other rare varieties of abnormal pelves, it frequently happens that pronounced deformity of the outlet occurs in pelves with otherwise approximately normal measurements.

*Measuring the Diameters of the Pelvic Outlet.*—In view of what has just been said, the determination of the space available between the tubera

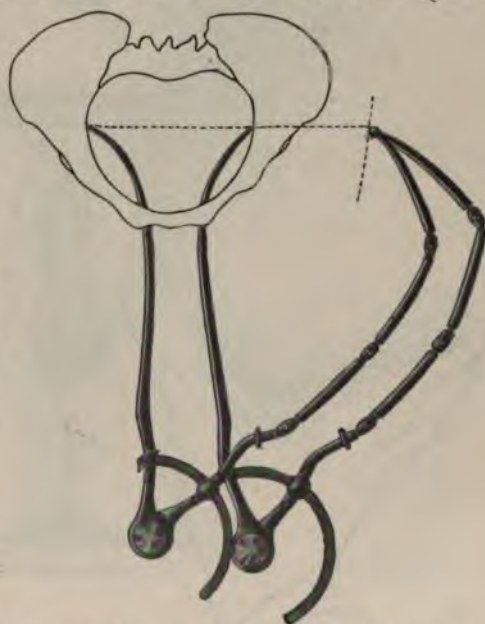


FIG. 532.—MEASURING TRANSVERSE DIAMETER OF SUPERIOR STRAIT WITH SKUTSCH'S PELVIMETER.



ischii should be made an integral part of the routine examination of the pelvis. An approximate idea may readily be obtained by Sellheim's method of palpating the pubic arch. For this purpose, the woman having been placed in the dorsal position with the hips protruding beyond the edge of

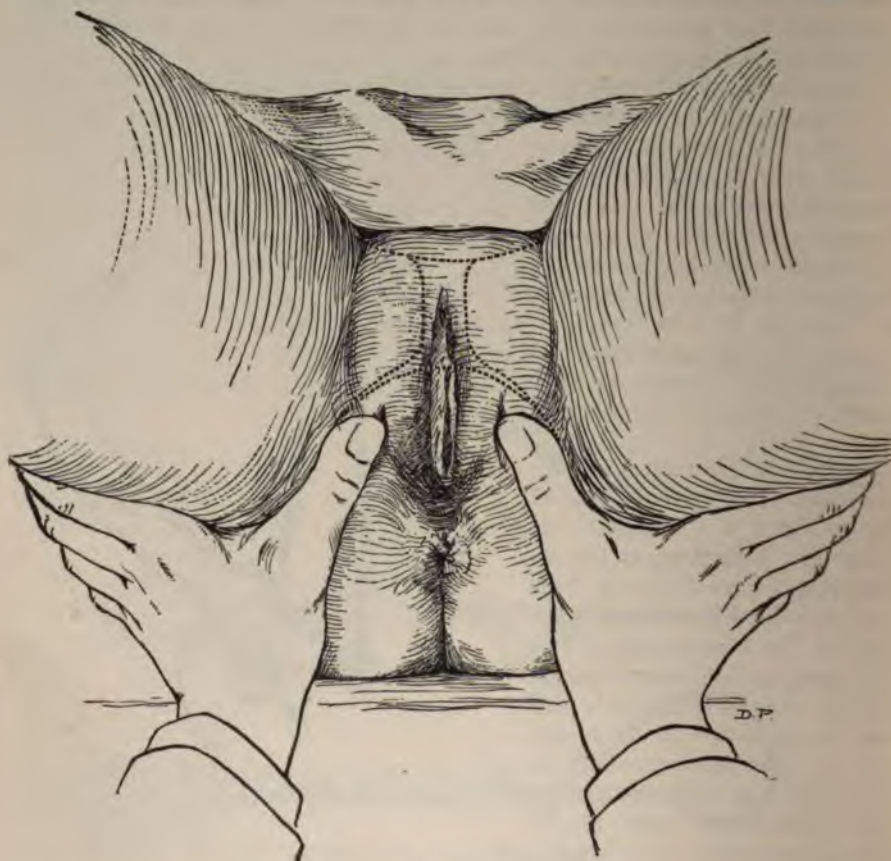


FIG. 533.—PALPATION OF PUBIC ARCH.

the bed or examining table and the legs drawn up, the buttocks are seized by both hands in such a manner that the web of the thumb comes in contact with the ischial tuberosity, while the thumb follows the course of the corresponding ischio-pubic ramus and the other fingers grasp the side of the thigh (Fig. 533). In this way the outlines of the pubic arch are very satisfactorily indicated by the position of the thumbs, so that with a little practice one can readily determine whether it is normal or contracted.

If the pubic arch appears to be narrowed, the transverse diameter of the outlet should be accurately measured, and, if it be 8 centimeters or less in length, still other measurements should be made. For this purpose the regions about both tubera ischii are carefully palpated with the thumbs, and, when the points corresponding to the ends of the diameter have been

located, the thumbs are brought into such a position that their nails represent the prolongation of the inner surface of each ischial bone. An assistant then measures the distance between them by means of a Budin or other suitable pelvimeter (Fig. 535). If an assistant is not available, equally

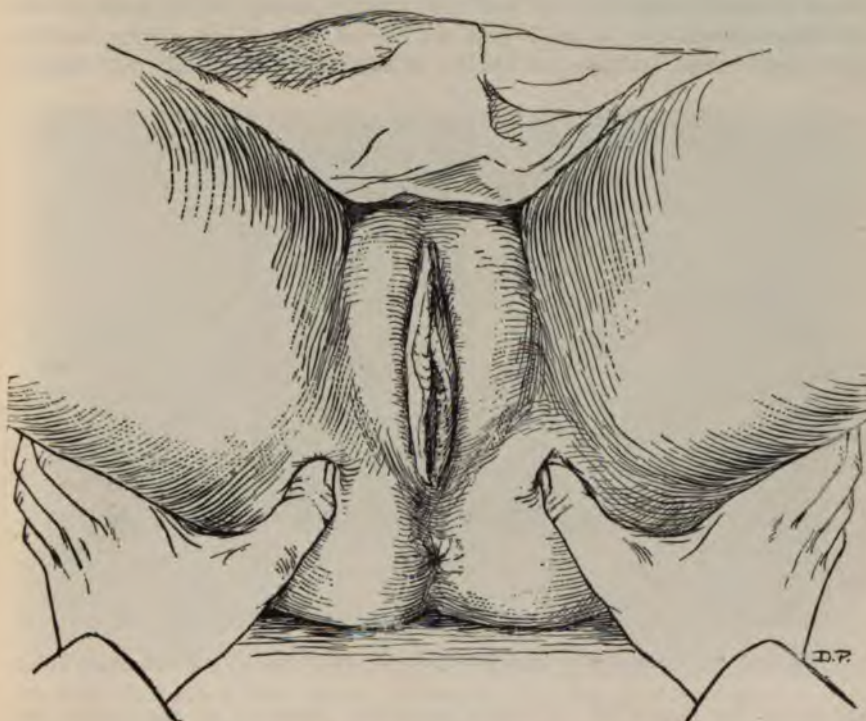


FIG. 534.—PALPATION OF ISCHIAL TUBEROSITIES.

satisfactory results may be obtained by using the outlet pelvimeter which I have devised, in which the tips of the blades are attached to the thumbs by adjustable rings (Fig. 536).

Direct measurement by means of the palpating fingers is to be preferred to the method described by Schroeder, in which, after carefully palpating the tuberosities, the skin corresponding to their inner margins is marked by means of a dermatographic pencil, and the distance between the two marks is measured. In view of the elasticity of the skin, however, it must frequently happen that considerable distortion will occur as soon as the pressure of the fingers is removed.

The antero-posterior diameter, between the lower margin of the symphysis and the tip of the sacrum, is readily measured by a modification of Breisky's method. For this, the woman should be brought so far down upon the table that the sacrum becomes readily accessible. Then its tip is located through the skin, one end of the pelvimeter is applied over it, and the other is applied to the lower margin of the symphysis pubis. A deduc-



tion of 1 centimeter from this measurement will give a tolerably accurate idea of the length of this diameter (Fig. 537).

Unfortunately, however, this knowledge is of but slight practical value in the cases in which it is most particularly desired, for the reason that, when the transverse diameter is markedly shortened, the pubic arch becomes so narrow that it is not available for the passage of the head, so that in extreme cases only a small segment of the occiput can engage between the tubera ischii. Consequently the possibility of its birth will depend

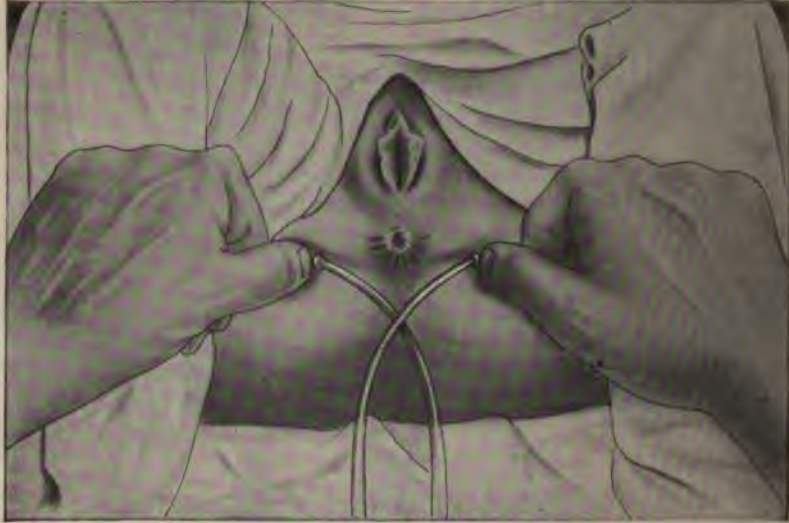


FIG. 535.—MEASURING THE DISTANCE BETWEEN THE TUBERA ISCHII.

not upon the length of the antero-posterior diameter of the outlet, but rather upon the distance available between the line joining the tubera ischii and the tip of the sacrum. This diameter was described by Klien as the posterior sagittal of the outlet, and should be measured whenever the transverse diameter measures 8 centimeters or less. This, however, requires the use of a special instrument, and will be considered in greater detail under the heading of Funnel Pelves.

*Use of X-rays.*—After the discovery of the Röntgen ray and the demonstration of the various uses to which it might be put, it was thought possible that it might also afford a valuable method of investigating the shape and size of the pelvis. Budin and Varnier, in 1897, reported their experience with it, and showed that, while it often gave an excellent idea of its shape, the ideas as to size obtained by it were erroneous. A comprehensive review of the literature upon the subject was given by Müllerheim in 1898.

Up to 1900 all radiographs of the pelvis gave distorted ideas in regard to its dimensions, owing to the fact that the sacrum lay much nearer the sensitive plate than the symphysis, and consequently the anterior portion of the pelvis was enlarged out of all proportion to the posterior. This defect

made it impossible to attempt to utilize the radiograph for purposes of mensuration. Bouchacourt suggested that it might be obviated by placing a rectangular metal frame about the woman's hips, more or less corresponding to the plane of the superior strait, each side of the frame being marked by indentations 1 centimeter apart. When the picture was taken these would also be reproduced, and on connecting the corresponding points upon the four sides of the picture a definite idea could be obtained as to the dimensions of the superior strait. A similar method was employed by

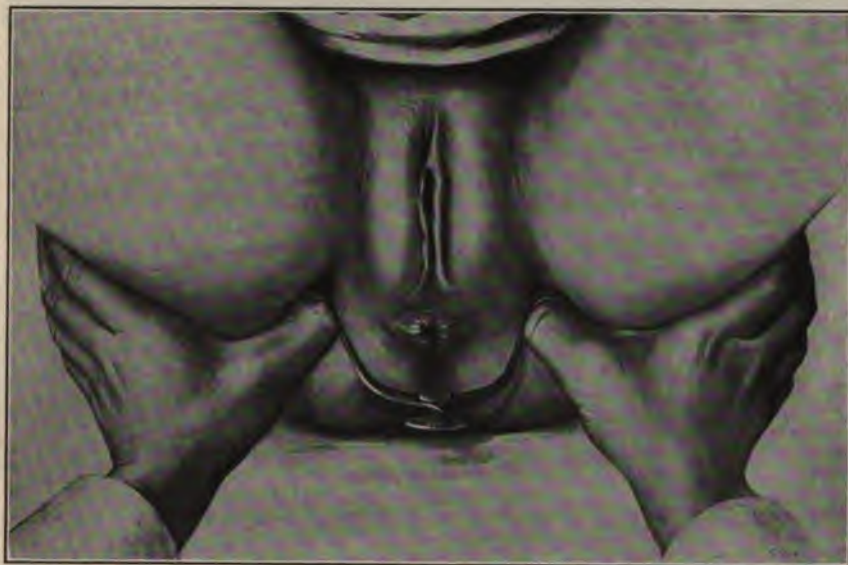


FIG. 536.—MENSURATION OF TRANSVERSE DIAMETER OF OUTLET WITH WILLIAMS'S PELVIMETER.  $\times \frac{1}{2}$ .

Fabre, of Lyons, and, according to Donnezan, has given most satisfactory results.

**Classification of Contracted Pelves.**—For the first classification of abnormal pelves we are indebted to Deventer, who distinguished three groups: too large, too small, and too flat pelves.

Most recent attempts at classification have been based upon the shape of the pelvis, without taking into consideration the ætiological factors which lead to its production. This method was adopted by Michaelis, and reached its greatest perfection in Litzmann's hands. The former thoroughly realized its inherent defects and regretted that other methods of classification could not be employed. Kilian, Busch, and Siebold had previously recognized the necessity of taking into account the ætiological factors which are concerned, but their knowledge was too meager to permit of such a course.

It was not until 1889 that Schauta was able to suggest a fairly satisfactory ætiological classification, which soon obtained general acceptance, although it was still far from ideal. Tarnier and Budin, in their treatise



issued in 1898, followed somewhat similar lines. Breus and Kolisko do not consider that either is perfectly satisfactory, and have suggested a substitute for them.

Owing to the fact that our knowledge of the fundamental factors underlying the production of many forms of abnormal pelvis is still very meager, and occasionally entirely lacking, it is apparent that at the present time no

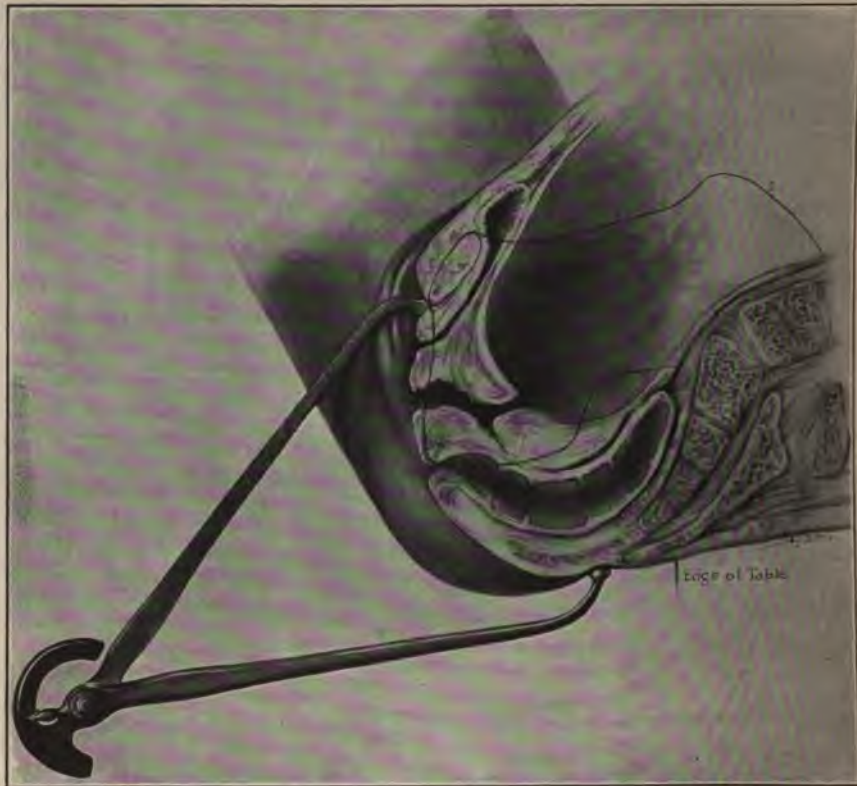


FIG. 537.—DIAGRAM SHOWING WILLIAMS'S MODIFICATION OF BREISKY'S METHOD OF MEASURING ANTERO-POSTERIOR DIAMETER OF OUTLET.  $\times \frac{1}{2}$ .

ætiological classification can be perfectly satisfactory, though from a practical point of view the one employed by Tarnier and Budin would seem to approach more nearly to it.

For convenience of reference we shall give the classifications of Tarnier and Budin and of Schauta in parallel columns; but although we shall generally follow the former in describing the several varieties, we shall not necessarily adhere to the order in which the different groups are arranged.

## TARNIER AND BUDIN'S CLASSIFICATION

I. *Pelvic Anomalies due to Excess of Malleability of Pelvic Bones:*

- (a) Rhachitic pelvis.
- (b) Flat, non-rhachitic pelvis.
- (c) Osteomalacic pelvis.

II. *Anomalies due to Abnormal Transmission of the Body Weight to Pelvis:*

- (a) Lordosis.
- (b) Scoliosis.
- (c) Kyphosis.

III. *Anomalies resulting from Abnormal Articulation of the Vertebral Column with the Sacrum:*

- (a) Spondylolisthesis.
- (b) Spondylizème.

IV. *Anomalies resulting from the Abnormal Direction of the Upward and Inward Force exerted by the Femora:*

- (a) Unilateral lameness.
- (b) Bilateral lameness.

V. *Anomalies resulting from Primary Defects in the Development of the Pelvic Bones:*

- (a) Generalized and symmetrical:
  1. Excess of general development (justo-major pelvis).

## SCHAUTA'S CLASSIFICATION

I. *Anomalies resulting from Faulty Development:*

- (a) Generally contracted pelvis.
- (b) Simple flat, non-rhachitic pelvis.
- (c) Generally contracted flat pelvis.
- (d) Narrow, funnel-shaped, fetal or undeveloped pelvis.
- (e) Imperfect development of one sacral ala (Naegele pelvis).
- (f) Imperfect development of both sacral alae (Robert pelvis).
- (g) Generally, equally enlarged (justo-major pelvis).

II. *Pelvic Anomalies resulting from Diseases of the Pelvic Bones:*

- (a) Rhachitic pelvis.
- (b) Osteomalacic pelvis.
- (c) New growths.
- (d) Fracture.
- (e) Atrophy, caries, and necrosis.

III. *Anomalies in the Articulation of the Pelvic Bones:*

- (a) Abnormally firm union (synostosis):
  1. Of the symphysis.
  2. Of one or both sacro-iliac synchondroses.
  3. Of the sacrum with the coccyx.

IV. *Anomalies resulting from Diseases of the Superimposed Skeleton:*

- (a) Spondylolisthesis.
- (b) Kyphosis.
- (c) Scoliosis.
- (d) Kyphoscoliosis.
- (e) Lordosis.
- (f) Assimilation.

V. *Anomalies resulting from Abnormalities of the Subjacent Skeleton:*

- (a) Coxitis.
- (b) Luxation of the head of the femur.
- (c) Luxation of the heads of both femora.



- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <p>2. Lack of general development (generally contracted pelvis).</p> <p>(b) Localized and asymmetrical:</p> <p>1. Obliquely contracted (Naegele) pelvis.</p> <p>(c) Localized and symmetrical:</p> <p>1. Double oblique (Robert) pelvis.</p> <p>2. Split pelvis.</p> <p>3. Ossification of sacro-iliac joints.</p> <p>4. Arrest of development of the body of the sacrum.</p> <p>VI. <i>Atypical Deformities:</i></p> <p>Tumors and fractures of the pelvic bones.</p> | <p>(d) Unilateral or bilateral club-foot.</p> <p>(e) Absence or deformity of one or both lower extremities.</p> |
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## CHAPTER XXXIV

### ANOMALIES DUE TO ABNORMAL MALLEABILITY OF THE PELVIC BONES

#### FLAT NON-RHACHITIC PELVIS

It is generally believed that this is the most usual variety of pelvic deformity occurring in white women, as it was noted in 43 per cent. of the contracted pelvis described by Michaelis. Litzmann stated that its frequency, as compared with that of the rhachitic pelvis, was as 7 to 5. In my experience, however, the funnel pelvis is the most usual abnormality in white women, and is followed by the generally contracted and the simple flat pelvis, while the latter occurs extremely rarely in black women.

The following table gives the relative incidence of the more common types of contracted pelvis in the two races, as observed at the Johns Hopkins Hospital in a series of 2,750 women, in whom the diameters of the pelvic outlet were also measured:

| WHITE                    |     |           | BLACK                  |     |           |
|--------------------------|-----|-----------|------------------------|-----|-----------|
| VARIETY OF PELVIS        | NO. | PER CENT. | VARIETY OF PELVIS      | NO. | PER CENT. |
| Funnel.....              | 77  | 44.00     | Generally contracted.. | 202 | 53.72     |
| Generally contracted...  | 60  | 34.29     | Gen. cont. rhachitic.. | 100 | 26.60     |
| Simple flat.....         | 26  | 14.86     | Funnel.....            | 58  | 15.43     |
| Gen. cont. rhachitic.... | 7   | 4.00      | Flat rhachitic.....    | 10  | 2.66      |
| Atypical.....            | 4   | 2.28      | Simple flat.....       | 4   | 1.06      |
| Flat rhachitic.....      | 1   | 0.57      | Atypical.....          | 2   | 0.53      |
| Total.....               | 175 | 100.00    | Total.....             | 376 | 100.00    |

In a series of 4,750 patients studied up to April, 1911, the simple flat pelvis occurred in 2.57 per cent. of the white and in 0.66 per cent. of the black women; and, upon omitting the outlet contractions, it represented 32 and 2 per cent. respectively, of all abnormal pelvis in the two races.

Most German authors confirm the statements of Michaelis and Litzmann as to its frequency. On the other hand, Ahlfeld dissents from this view, holding that many of the pelvis which have been designated as of the simple flat variety are really of rhachitic origin, and Tarnier and Budin state that only one sixteenth of the abnormal pelvis with which they met could be attributed to other causes than rhachitis.



This variety is frequently described as the *pelvis plana Deventeri*, or *simple flat pelvis*, although it is doubtful whether Deventer differentiated between it and the rhachitic form. It was accurately described by Betschler in 1832, but Michaelis and Litzmann were the first to insist upon its importance and frequent occurrence.

The characteristic feature of the flat non-rhachitic pelvis consists in a shortening of all the antero-posterior diameters of the pelvic cavity, while the transverse measurements remain practically normal.\* This condition



Fig. 538.



Fig. 539.



Fig. 540.

FIGS. 538-540.—FLAT NON-RHACHITIC PELVIS.

is due to the fact that the entire sacrum approaches more nearly than normal to the symphysis pubis. At the same time it undergoes a slight rotation about its transverse axis, as is shown by the fact that the contraction is always more marked in the superior than in the inferior strait. The

\* The illustrations in the chapters on Contracted Pelves have been prepared with great care. The half-tone illustrations are exactly one-third natural size, and were drawn from photographs which were taken with the pelvis as nearly as possible in the same position—that is, with the tip of the coccyx and upper margin of the symphysis pubis on the same horizontal level. Accordingly, the illustrations can be accurately compared.

The diagrams of the superior strait and the sagittal sections through the pelvic cavity are one-sixth natural size, and are accurate to within one millimeter. The former were made by means of the camera with the plane of the superior strait at right angles to the horizon. The latter were made from tracings of casts of the pelvic cavity obtained by means of dental wax, and reduced by the pantograph.

degree of contraction is usually not very pronounced, and it is rare to find the conjugata vera measuring less than 8 centimeters. In fact, whenever this limit is passed, the probability that one has to deal with a flat rhachitic pelvis should always be borne in mind.

The sacrum does not present the characteristic features of rhachitis, and preserves its normal vertical and side to side concavity. Occasionally it may appear somewhat more delicately shaped than usual, and be narrower transversely. In such circumstances the transverse diameters of the pelvic cavity are also slightly decreased.

In not a few pelvises of this character the line of ossification between the first and second sacral vertebra is more marked than usual, thus giving rise to a so-called second or accessory promontory.

**Ætiology.**—By many European authorities it is believed that the approach of the sacrum to the symphysis results from the carrying of heavy burdens upon the back or head during early life, though such an explanation cannot apply in this country, where it is unusual for girls to carry heavy loads. In other cases the condition is attributed to the fact that the child was allowed to sit up at too early an age and for too long periods.

Ahlfeld, Tarnier, and Breus and Kolisko think that a part in the production of the deformity is played by rhachitis, which, they hold, may be present in a larval form without giving rise to its usual and characteristic manifestations. The latter state that the shortening of the conjugata vera is not so much due to a rotation of the sacrum as to the shortening of the iliac portion of the terminal length of the innominate bone; and, as they believe that this is usually the result of rhachitis, they consider that it aids materially in determining the ætiology of the condition.

Fehling and Schliephake consider that this variety of pelvic anomaly is congenital in a certain number of instances, as they have shown that the pelvises of newly born children may occasionally present a flattened appearance. In several cases studied by them the relation between the conjugata vera and the transverse diameter of the superior strait was as 100 to 145, 100 to 160, or 100 to 177, instead of 100 to 122, as is usually the case. Under such circumstances the mechanical factors above alluded to could certainly not have come into play.

**Diagnosis.**—The presence of a simple flat pelvis, as a rule, is readily detected. By external pelvimetry the distances between the spines and crests of the ilium, as well as between the trochanters, are found to be approximately normal, whereas Baudelocque's diameter is more or less shortened. On internal examination the diagonal conjugate is found to be shortened, though never to an extreme degree. In general, if it falls below 9 centimeters the pelvis does not belong in this category. The entire anterior surface of the sacrum appears to be nearer the symphysis than usual, but presents its normal curvatures. There is no widening of the transverse diameter of the pelvic outlet, as in the rhachitic form. The average measurements in 26 of my cases were: spines, 25.7; crests, 27.8; trochanters, 30.5; Baudelocque's diameter, 18; and diagonal conjugate, 10.7 centimeters.

The consideration of the effect of the flat pelvis upon the course of labor, and the treatment of such cases, will be deferred until the flat rhachitic



pelvis is studied, as there is no essential difference in the mechanism of the two varieties.

### RHACHITIC PELTS

In many parts of Europe one of the most prominent factors in the production of contracted pelves is an abnormal softening of the bones in early life resulting from rhachitis. In this country the disease is observed comparatively rarely in white children, occasionally in colored children inhabiting the country districts, and very frequently in those living in large cities.

In not a few cases the disease undergoes spontaneous cure, so that no trace of its existence can be discovered in later life; while in many instances permanent skeletal deformities result which are frequently localized in the pelvis. Again, it is also not unusual to meet with women who to all appearances are quite normally formed, but whose pelves upon examination present rhachitic deformities. Rhachitic pelves were noted in 0.8 per cent. of the white and 10.8 per cent. of the black women delivered at the Johns Hopkins Hospital up to April, 1911. Omitting outlet contractions, they constituted 9 and 33 per cent., respectively, of the abnormal pelves observed in the two races, thus showing that even in this country the disease is of marked importance from an obstetrical standpoint.

**Nature and Pathology of Rhachitis.**—Before describing the various changes in the pelvis which may result from rhachitis, it will be well to consider chiefly the nature and pathology of the disease.

Unfortunately it is impossible to make absolutely clear-cut statements in this regard, more particularly as the work of Schmorl, Recklinghausen, Ogata, and others tends to indicate that the difference between rhachitis and osteomalacia is nothing like so marked as was formerly believed. According to Kassowitz, Spillmann, and others, the former is to be looked upon as an osteitis associated with an excessive formation of osteoid tissue at the

epiphyses and beneath the periosteum of the long bones, as well as in the flat bones of the skull and pelvis. The proliferation is accompanied by defective calcification of the newly formed tissue, Zweifel stating that only

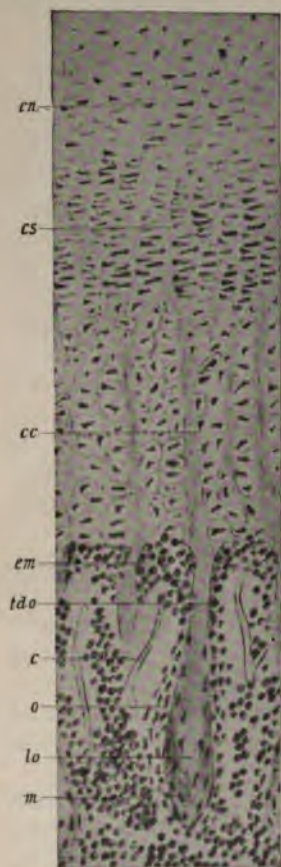


FIG. 541.—SECTION THROUGH NORMAL EPIPHYSIS OF CHILD (Spillmann).

*cn.*, normal cartilage; *cs.*, cartilage cells arranged in parallel rows; *cc.*, area of preliminary calcification; *cm.*, medullary spaces; *o.*, osteoblasts; *lo.*, osseous lamellæ; *m.*, marrow.

18 to 24 per cent. of inorganic salts are present, as against 63 to 65 per cent. in normal bone.

It is customary to distinguish three stages in the disease: congestion, softening, and progressive deformity or cure, as the case may be. In the first stage there is a great increase in vascularity, which is most marked at the union of the articular cartilages with the diaphyses of the long bones and also beneath the periosteum. In the former location the zone of preliminary calcification—Guérin's line—is slightly thickened, and its lower portion adjacent to the newly formed spongy bone is perforated by numerous vascular loops. A similar condition may also be observed beneath the periosteum covering the long and the flat bones (Fig. 542).

In the second stage, while Guérin's line has become markedly thickened and very irregular, the vascular proliferation has advanced to a marked degree. Under the microscope the former is seen to be broken up in all directions by the rapidly growing vascular loops, which subdivide it into large numbers of small, irregularly shaped calcific areas. At the same time the formation of osseous tissue just beneath it proceeds in an irregular manner, calcification either failing to occur or taking place imperfectly. The newly formed tissue is penetrated in all directions by vascular loops which break it up into small masses, between which and the marrow cavities is a considerable formation of osteoid tissue, with spindle- and star-shaped cells, which does not become ossified at all.

To summarize these changes briefly, one may say that the growing end of the bone, instead of undergoing normal ossification, consists in great part of dilated capillaries which separate irregularly shaped masses of calcified cartilage from areas of connective tissue and imperfectly formed bone (Fig. 543). More or less similar changes take place under the periosteum of the long and flat bones, so that the shaft of the bone soon becomes converted into a spongy tissue corresponding closely to that observed at the epiphysis.

In the third period these changes continue until death occurs; or, if recovery ensues—the usual outcome—there is a progressive decrease in vascularity, and the normal process of ossification is resumed, so that after a time the only trace of the disease is to be found in an atrophy of the bone, which is frequently associated with thickening and an increased porosity. It is therefore apparent that the bones become abnormally soft and yielding in

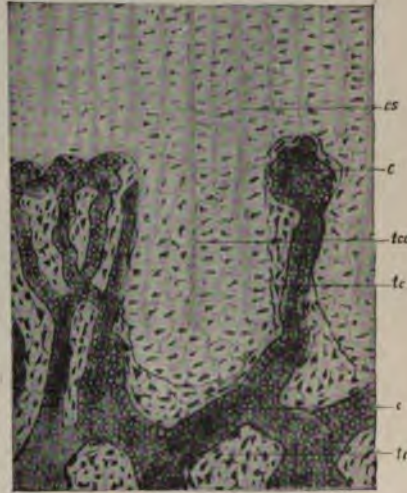


FIG. 542.—SECTION THROUGH EPIPHYSIS IN EARLY STAGES OF RHACHITIS (Spillmann).

*cs.*, cartilage cells arranged in parallel rows; *tcc.*, area of preliminary calcification; *c.*, capillary; *tc.*, unossified connective tissue.



the acute stages of the disease, so that if the child uses its extremities at the time, more or less marked deformity must result, depending upon the mechanical influences which are liable to modify the evolution of the infantile pelvis. Breus and Kolisko insist that practically no growth occurs during the acute stage of the disease, and, consequently, if it persists for any length of time, it must inevitably lead to atrophic changes, so that after recovery the bones are smaller and somewhat lighter than normal, even though they show no characteristic signs of deformity.

**Forms of Rhachitic Pelves.**—As has already been said, the rhachitic type is one of the most frequently observed varieties of contracted pelvis,



FIG. 543.—SECTION THROUGH EPIPHYSIS IN ADVANCED STAGES OF RHACHITIS (Spillmann).  
*tcc.*, area of preliminary calcification; *cc.*, calcified cartilage; *c.*, capillaries;  
*tc.*, connective tissue.

and in extreme cases presents the most marked deformities with which we are familiar, with the exception of those resulting from osteomalacia. Fortunately, however, the degree of contraction is usually not very pronounced, Tarnier having found that the conjugata vera measured less than 8.5 centimeters in only 14.4 per cent. of 1,020 rhachitic pelvis.

With the exception of the cases which are complicated by abnormalities of the vertebral column, or by deformities giving rise to a marked difference in the length of the limbs, rhachitic pelvis are usually classified as follows:

1. Flat rhachitic.
2. Generally contracted, flat rhachitic.
3. Generally and equally contracted rhachitic.
4. Pseudo-osteomalacic.

1. *Flat Rhachitic Pelvis*.—In this variety the greatest contraction occurs in the antero-posterior diameter of the superior strait, while the transverse diameter is seldom affected, or may even be slightly longer than usual.



Fig. 544.



Fig. 545.

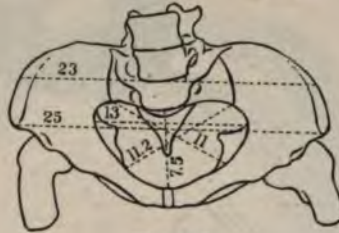


Fig. 546.

FIGS. 544-546.—FLAT RHACHITIC PELVIS.

Generally speaking, the bones are less dense in texture than usual, and frequently are delicate in form, though occasionally they may appear clumsy and swollen. Owing to the marked lordosis, which frequently

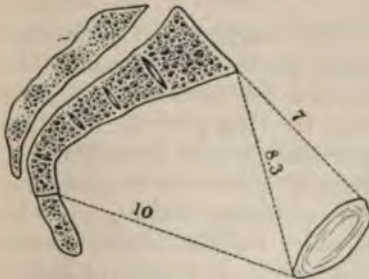


FIG. 547.—ACCENTUATION OF VERTICAL CONCAVITY OF SACRUM IN RHACHITIS.

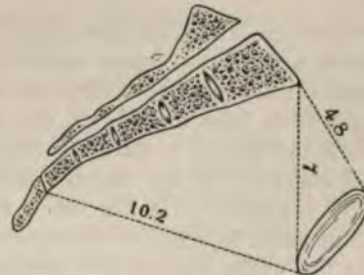


FIG. 548.—SHOWING OBLITERATION OF VERTICAL CONCAVITY OF SACRUM IN RHACHITIS.



results from rhachitis, the pelvic inclination, as a rule, is considerably increased.

Most important changes are to be noted in the sacrum, which differs from the normal in that it is broader from side to side, thinner from behind forward, shorter from above downward, and less concave on its anterior surface. The longitudinal axis of the bone is so altered as to form a greater angle with the conjugata vera, and consequently the promontory lies at a lower level than usual, approaches the symphysis pubis, and encroaches markedly upon the area of the superior strait. Usually the



Fig. 549.

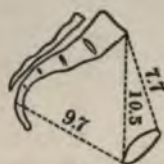


Fig. 550.



Fig. 551.

FIGS. 549-551.—FLAT RHACHITIC PELVIS, SHOWING DOUBLE PROMONTORY.

entire sacrum is sharply bent upon itself in the neighborhood of its third vertebra, so that its vertical concavity becomes markedly accentuated. Occasionally this does not occur, and in such cases the sacrum may be quite straight from base to tip. At the same time the bodies of the individual vertebrae extend out beyond the level of their alae, thereby diminishing the lateral concavity of the sacrum, and occasionally converting it into a pronounced convexity. In the latter event the spinous processes project less far than usual beyond the posterior surface, which tends to become concave.

As the upper part of the sacrum becomes displaced downward and inward, its posterior surface recedes from the superior posterior spines of the ilium, which approach one another more closely than in the normal

condition, so that the posterior limb of the "S"-shaped curvature of the iliac crests becomes accentuated.

Occasionally the anterior surface of the sacrum may be convex in both directions, and, when directed more vertically than usual, it may happen that the greatest convexity will correspond to the region of the second and third sacral vertebræ. In this event the shortest diameter of the pelvis will correspond to the antero-posterior of the plane of greatest pelvic dimensions instead of the conjugata vera. Breus and Kolisko have classified such pelves in a special group and designated them as "middle flat." In such cases the promontory of the sacrum is not displaced downward, and the condition is usually associated with assimilation.

Occasionally the body of the first sacral vertebra is more markedly displaced forward than those below it, so that its lower margin projects beyond the general surface, and can be felt as a *false*, or double, *promontory*. In such circumstances the distance between it and the symphysis pubis may be shorter than the conjugata vera. The presence of a false promontory is usually indicative of the assimilation of an extra vertebra to the sacrum, and its significance will be discussed when assimilation pelves are considered.

The iliac bones are smaller and frequently more delicately shaped than usual, the vertical height of the pelvis as well as the length of the iliac crests being diminished. The iliac fossæ are more concave, and frequently present a pronounced, sharp depression just in front of the sacro-iliac joint. As a result the anterior margin of the bone extends more vertically than usual, as is shown by comparing the slant of the line joining the acetabu-

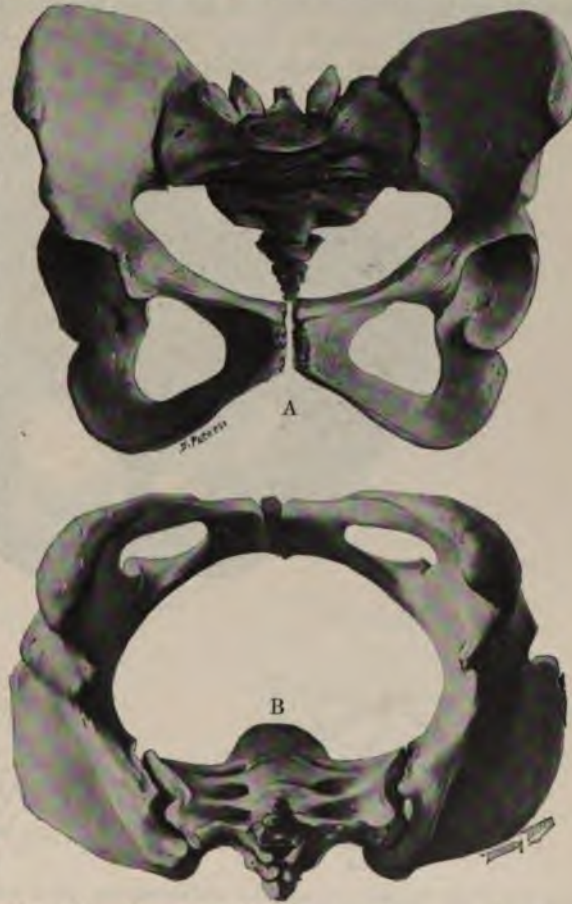


FIG. 552.—GENERALLY CONTRACTED RHACHITIC ASSIMILATION PELVIS.  $\times \frac{1}{2}$ .

A, anterior view; B, same pelvis seen from below showing relative widening of outlet.



lum and the anterior superior spine of the ilium. At the same time the anterior portion of the bone flares out at the expense of the crest, so that the distance between the anterior superior spines approaches that between the crests, and occasionally even exceeds it in length.

The diminution in the size of the iliac bone is perhaps best appreciated by studying the "terminal length" (Figs. 27 and 28). Normally, its component parts are practically of the same length, but in the rhachitic pelvis the pubic portion retains its normal dimensions, the sacral portion is only slightly shorter than usual, while the iliac portion is greatly shortened, and occasionally presents only a fraction of its normal length. Breus and



Fig. 553.



Fig. 554.



Fig. 555.

FIGS. 553-555.—GENERALLY CONTRACTED, FLAT RHACHITIC PELVIS.

Kolisko have laid great stress upon this change, and consider it almost pathognomonic of rhachitis.

In many cases the iliac bones bend just in front of the sacro-iliac synchondrosis, so that the ilio-pectineal line, instead of following a gentle curve, forms a sharp angle at that point, thus adding materially to the flattening of the superior strait. At the same time the acetabula are displaced forward, and thus come to lie upon the anterior instead of upon the lateral portion of the pelvic ring.

The pubic arch is usually wider than normal, and the tubera ischii are so everted that the transverse diameter of the outlet appears to be exag-

gerated, and occasionally measures more than in the normal pelvis. In view of the upward and backward dislocation of the tip of the sacrum, the antero-posterior diameter of the outlet is also either relatively or absolutely increased in length. Consequently, in contrast with the flattened superior strait, the pelvic outlet appears wide and gaping, and in extreme cases may be nearly twice as roomy as the inlet (Fig. 552, A and B).

These changes exert a decided influence upon the shape of the pelvic cavity, the effect being most marked in the superior strait, which may become oval, reniform, or even heart-shaped in outline, according to the



Fig. 556.

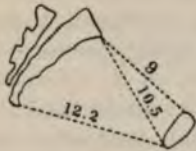


Fig. 557.

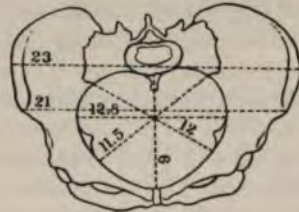


Fig. 558.

FIGS. 556-558.—GENERALLY EQUALLY CONTRACTED RHACHITIC PELVIS.

degree of displacement of the promontory of the sacrum. The conjugata vera is always shortened, while the transverse diameter seems to be enlarged, although this may be only apparent unless the pelvis be of large size. Owing to the approach of the anterior and posterior walls of the pelvis, the oblique diameters of the superior strait are always shortened, as are also the sacro-cotyloid diameters.

In occasional cases sharp exostoses may make their appearance upon the pubic crests, the ilio-pectineal eminences, or in front of the sacro-iliac synchondroses—*pelvis spinosa*. When such structures are not well covered by soft parts, they may lead to injury of the uterus at the time of labor.

2. *Generally Contracted, Flat Rhachitic Pelvis*.—It is in this variety of pelvis that marked degrees of contraction are often encountered, the con-



jugata vera sometimes being reduced to 3 or 4 centimeters. This pelvis corresponds closely to the ordinary flat rhachitic type, except that the shortening applies to all its diameters instead of being limited to the conjugata vera. Notwithstanding the fact that all of the diameters of the inferior strait fall below the normal limits, the outlet usually appears abnormally large when compared with the generally contracted inlet (Fig. 552).

The decrease in size is particularly marked in the sacrum, which may present a considerable diminution in its transverse measurements. The small size of the pelvis in such cases may be due either to atrophic changes in the bones resulting from the rhachitis itself, or to the fact that a primarily small pelvis had become affected with the disease.

3. *Generally Equally Contracted Rhachitic Pelvis.*—This variety was first described by Michaelis, and according to most authors is observed but rarely. Müller, however, considers that not a few cases which were previously described as instances of simple, generally contracted (justo-minor) pelvis belong under this category, and my own experience, particularly in the negro race, has tended to confirm his observations.

According to Litzmann, this type differs from the justo-minor pelvis in its ungainly and angular appearance, and in the marked prominence of the pubic crests. The superior strait appears to be equally shortened in all its diameters instead of merely flattened, while the rest of the pelvis presents indisputable signs of a past rhachitis, which is more particularly marked in the sacrum and in the eversion of the tubera ischii.

4. *Pseudo-osteomalacic Rhachitic Pelvis.*—This variety is a manifestation of the severest forms of rhachitis, and affords examples of the most marked degrees of contraction. In such cases, as the name implies, the pelvis resembles one deformed by osteomalacia, the sacrum and lateral walls approaching one another so as to give rise to a very small, trefoil-like superior strait, the contraction also extending to other portions of the pelvic cavity.

This form of pelvis was first described by Smellie, who depicted it by an illustration in his anatomical plates. More particular attention was directed to it by Stein, and especially by Naegele. It is not of frequent occurrence, though Fasbender in 1878 was able to collect 40 cases from the literature, not a few of which occurred in young children.

**Diagnosis of Rhachitic Pelves.**—Important information as to the presence of rhachitis may be elicited by inspection of the patient when characteristic deformities may be noted about the head, vertebral column, and lower extremities. In not a few cases the presence of thickened epiphyses at the costal margins—the so-called rhachitic rosary—may also serve to call attention to the existence of the disease.

A decidedly pendulous abdomen in primiparous women is always suggestive of marked disproportion between the size of the head and the pelvis, and should suggest a search for rhachitic changes.

The age at which the patient first learned to walk is also of considerable importance, as it is well known that children suffering from rhachitis are usually backward in this respect. Again, when the disease appears

after the first year of life, the child usually ceases to walk during its acute stages, and has to learn again at a later period.

Accurate information concerning the pelvis, however, can be obtained only by pelvimetry. On external mensuration the distances between the spines and crests of the ilium no longer show their normal relations, but the former approach, and not infrequently exceed, the latter in length. Normally, there is a difference of 2.5 to 3 centimeters between the two, and



FIG. 559.—PSEUDO-OSTEOMALACIC PELVIS (Naegele).

whenever this becomes reduced to 1 centimeter or less rhachitis should be suspected. The distance between the trochanters will be normal or not, according as one has to deal with a flat or generally contracted rhachitic pelvis. Baudelocque's diameter is always considerably shortened. At the same time Michaelis's rhomboid loses its regular outlines, and in marked cases, owing to the sinking downward and forward of the sacrum, becomes converted into a triangular area. The pubic arch is usually widened, and the transverse diameter of the outlet either relatively or absolutely increased in length.

Still more definite information may be gained by internal pelvimetry and palpation of the pelvic cavity. The diagonal conjugate is always shortened. The anterior surface of the sacrum is much more readily accessible to the examining fingers, and on careful palpation its upper portion is found to be flatter than usual, while its lower portion is sharply bent forward. Moreover, owing to the prominence of the vertebral bodies, the sacrum is convex from side to side, instead of concave, as normally.

The average measurements in ten rhachitic pelvis in white women were: Spines, 25.4; crests, 25.7; trochanters, 29.3; Baudelocque, 17; and diagonal conjugate, 10.1 centimeters; while in 79 colored women the measurements averaged: Spines, 23.7; crests, 24.4; trochanters, 28.6; Baudelocque, 17.3; and diagonal conjugate, 10.6 centimeters.

The difference in the measurements between the spines and crests in the two races is due to the lesser flaring of the iliac bones and the generally smaller size of the pelvis in colored women. Thus, in two series of 707 and 470 normal pelvis respectively, the spines and crests measured 25.5 and 28 centimeters in white, as compared with 24 and 26 centimeters in colored women.

The flat rhachitic pelvis is ordinarily diagnosed when the transverse



external measurements show but slight diminution, whereas in the generally contracted variety they measure considerably less than normal. The generally and equally contracted variety is rarely diagnosed during life, while the characteristic deformity of the pseudo-osteomalacic form will be recognized on internal examination, and the decision as to whether it is due to rhachitis or osteomalacia will be determined by the history of the patient.

**Mode of Production of Deformity in Rhachitic Pelves.**—In Chapter I we considered the part played by various mechanical factors in the transformation of the foetal into the adult pelvis. Prior to the work of Breus

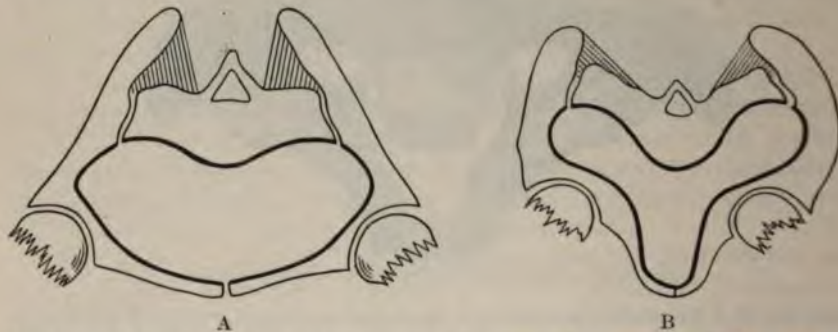


FIG. 560.—DIAGRAMS SHOWING CHANGES IN SHAPE IN RHACHITIC AND OSTEOMALACIC PELVES (Schroeder).

and Kolisko, it was generally believed that abnormalities and variations in their mode of action upon the softened pelvis also served to explain the production of most of the characteristic rhachitic deformities. This doctrine was developed in great part by Litzmann and Schroeder, and obtained almost general acceptance.

In the acute stages of rhachitis the young child is unable to walk, and spends its time in a sitting or reclining position, in which the upward and inward force exerted by the femora is in abeyance. Consequently, the body weight is the only force which comes into play, and on being transmitted from the vertebral column to the sacrum it is resolved into two forces—one directed downward and the other forward. As a result, the sacrum rotates about its transverse axis, the promontory being pressed forward and downward, while the remainder of the bone moves in the opposite direction and tends to assume a more or less horizontal position. The extreme upward dislocation of its lower end is resisted by the traction exerted upon it and the coccyx by the strong sacro-sciatic ligaments, and consequently the softened bone becomes sharply flexed at its lower portion, whereby its vertical concavity is accentuated. At the same time, owing to the softened condition of the sacrum and the imperfect union between the bodies and *alæ* of its *vertebræ*, the former are pushed out beyond the latter, thus converting its normal lateral concavity into a convexity.

As the promontory is displaced forward and downward under the influence of the body weight, the posterior surface of the sacrum recedes from the superior posterior spines of the ilium, thus subjecting the strong ilio-

sacral ligaments to marked tension. As a result, the posterior spines are drawn nearer to the middle line, while at the same time the anterior portions of the iliac bones flare out, thus accounting for the changed position of the anterior superior spines. This movement is resisted by the cohesive force exerted at the symphysis pubis, and as a consequence the softened bones bend just in front of the sacro-iliac synchondrosis, so that the iliopectineal line on either side, instead of following a gentle curve, becomes sharply bent at that point.

Coincident with these changes, the positions of the acetabula become altered, being situated upon the anterior, instead of upon the lateral, walls of the pelvis. As a result, when the child begins to walk the forces exerted by the femora also add to the flattening of the superior strait. On the other hand, owing to the previous non-use of the lower extremities, these last forces have not been called into play early enough to counteract the widening of the pelvic outlet as a result of prolonged sitting, and consequently the ischial tuberosities become flared out.

The same factors are concerned in the production of the generally contracted rhachitic pelvis, its small size being due either to atrophy following the rhachitis, or to the effect of the disease upon a pelvis already abnormally small.

The pseudo-osteomalacic form results when the rhachitic softening of the bones is very marked and the child persists in walking. In such circumstances not only are the characteristic changes in the sacrum and iliac crests produced, but at the same time the anterior wall of the pelvis is compressed and its lateral portions are pushed in toward the sacrum, the pelvic cavity becoming almost obliterated.

The mechanical doctrine just outlined was more or less opposed by Fehling, Freund, Kehrler, and others. The former held that the characteristic form of the pelvis may result *in utero*, from the so-called foetal rhachitis, before the various mechanical factors can come into play. Porak and Kaufmann, however, have shown that this condition differs radically from true rhachitis (Fig. 581), and have designated it as achondroplasia and chondrodystrophia foetalis, respectively. Consequently deformities resulting from it cannot be compared with those resulting from rhachitis.

Freund has attempted to show that in view of the peculiar nature of the sacro-iliac joints the sacrum cannot rotate about its transverse axis. His argument, however, appears to have been based in great part upon conditions observed in adult life, and he seems to have lost sight of the fact that the articular surfaces in early life are almost entirely cartilaginous, and thus readily permit of motion in any direction.

Kehrler believed that the action of certain groups of muscles plays a most important part in the production of abnormal pelves. No doubt this is true to a certain extent, but it is hardly probable that it is the only factor concerned.

On the other hand, Breus and Kolisko claim that the views of Litzmann and Schroeder are in great part erroneous, as they hold that most of the rhachitic deformities can be explained without invoking the intervention of the various mechanical forces. They have shown that rhachitis



not only gives rise to a general softening of the pelvic bones, but manifests itself more particularly in the imperfect development of the ilium and sacrum. Consequently the flattening of the superior strait is in great part due to the imperfect growth of the iliac portion of the innominate bone, while the pubic and sacral portions are but little affected. Such an abnormality must inevitably lead to the shortening of the antero-posterior diameter, while, as the result of the normal development of the pubic portion, the transverse diameter will become relatively lengthened.

Moreover, they contend that the displacement of the sacrum is not due to rotation about its transverse axis, but rather to the fact that the lack of development at the sacral end of the iliac portion of the innominate bone interferes with the normal backward displacement of the sacro-iliac joint. At the same time they are willing to admit that the changes in the curvatures of the sacrum may be due to the action of purely mechanical factors.

Their investigations have thrown great light upon the mode of production of rhachitic deformities of the pelvis, but at the same time I do not believe that they should be accepted as the only explanation. Accordingly, it would seem that three factors are concerned in the genesis of these deformities: (1) abnormalities in the development of the rhachitic bones; (2) the mechanical action of the various forces upon the softened bones; and (3) the traction or compression exerted by various muscles and ligaments.

### OSTEOMALACIC PELVES

Inasmuch as osteomalacia gives rise to the most marked pelvic deformities with which we are familiar, it was only natural that the attention of obstetricians should have been directed to it at an early date. Cooper performed Cæsarean section for this condition in 1768, but for the main pioneer work we are indebted to Stein, Kilian, and Litzmann.

**Nature and Clinical History of Osteomalacia.**—Osteomalacia, halisteresis, mollities ossium, or malacosteon disease is a chronic inflammatory disease of the bones, which become soft, yielding, and occasionally brittle, and consequently undergo marked changes in shape as the result of the action of the various mechanical forces to which they are subjected.

The disease is one of adult life, and is very rarely met with in children. It occurs far more frequently in women than in men, especially during pregnancy or the puerperium. Litzmann, in 1861, collected 131 cases from the literature, 85 of which were in pregnant or puerperal women, 35 in non-pregnant women, and 11 in men. Since that time the number of cases in women has markedly increased, whereas in 1900 Hahn was able to add only 31 additional instances in males.

The disease may occur in any part of the world, but is especially frequent, and may even be said to be endemic, in certain localities, notably in the Rhine Valley, the Ergolz Valley in Switzerland, the Olona Valley and Calabria in Italy, and in the city of Vienna. It is very rarely observed in this country, England, or France, Dock having been able to collect only 10 cases in America up to 1896. Tarnier, in his large experience,

encountered only 3 cases in Paris, and Hirst and myself have seen the same number of cases in Philadelphia and Baltimore.

Unless we are prepared to accept the bacterial origin of the disease, as urged by Arcangeli and other Italian investigators, no satisfactory explanation for its endemic occurrence has been adduced, but it seems to be intimately connected with unsanitary surroundings and inferior food. This was strikingly illustrated by the experience of Winckel, Sr., in Gummersbach in Germany, and of Hoebecke in Sottegem in Holland. The former performed 13, and the latter 14 Cæsarean sections upon osteomalacic patients prior to 1840. Since that time improvement in the hygienic conditions of both villages, together with more healthy occupation for their inhabitants, has led to an almost total disappearance of the disease. On the other hand, it may suddenly become endemic in localities in which it was previously unknown, as was illustrated by Ogata's experience in the province of Toyama in Japan.

Osteomalacia may affect any portion of the skeleton, but seems to select more particularly the pelvis, vertebræ, and ribs. The fresh bones are yellowish or yellowish-brown in appearance, and very soft and brittle. In advanced cases their consistence is that of leather or wax, so that they can readily be cut with a knife. In the later stages of the disease the spongy bones present a markedly areolated appearance on section, and in some instances are so rarefied that only the outer layers remain intact. At the same time they become much lighter, the specific gravity being frequently reduced by one half.

Under the microscope the marrow spaces are found to be greatly enlarged, and there is a marked increase in vascularity. The most important change, however, consists in the substitution of osteoid tissue in place of the true bone surrounding the Haversian canals.

All of the earlier writers upon the subject considered that the changes in the bone resulted from decalcification, which was due to the presence of lactic or a related acid in the circulating blood. But, after the correctness of this view had been denied by Virchow in 1852, the writers upon the subject became divided into two camps: the one claiming that the essential feature of the disease is decalcification, and the other, a disturbance in the relation between resorption and apposition, by which osteoid instead of osseous tissue is formed. Full details of this discussion are to be found in the writings of Gelpke, Winckel, Laufer, Dibbelt, Marquis, and Christofolletti.

One of the most important contributions to the subject was made by Fehling in 1888, who advanced the theory that the disease was a trophoneurosis of ovarian origin. He believed that characteristic changes could be made out in the ovaries, and that these gave rise to reflex stimulation of the vasodilators supplying the bones. Although this theory serves to explain the brilliant results following castration in this disease, the various authorities are not yet agreed concerning the changes in the ovaries.

More important, from a practical standpoint, is the clinical history of the affection. In its earliest stages it is characterized by peculiar muscular palsies, which more especially affect the ilio-psoas, and which are



often accompanied by contractures of the abductor muscles of the thigh and by increased patellar reflexes. A little later rheumatoid pains make their appearance in various portions of the body, and at the same time the pelvis, ribs, and vertebral column become very sensitive upon pressure.



Fig. 561.

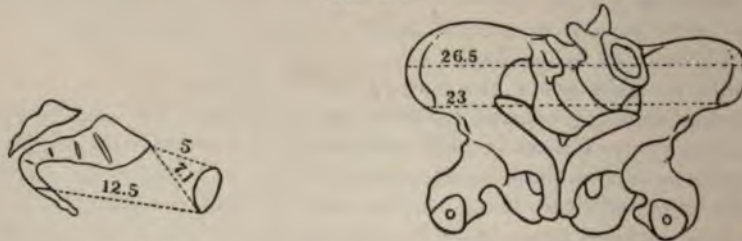


Fig. 562.

Fig. 563.

FIGS. 561-563.—OSTEOMALACIC PELVIS.

As the disease advances still further and the bones become softer, various deformities appear, which are particularly marked in the vertebral column and pelvis.

The history of osteomalacic patients is usually quite characteristic: The multiparous woman complains of muscular symptoms and rheumatoid pains during pregnancy. The same symptoms recur with added intensity in the succeeding pregnancy, and labor becomes more difficult. Should pregnancy again occur, the rheumatoid pains become severe and locomotion is so interfered with that for the last months the patient is obliged to take to her bed, and craniotomy or Cæsarean section is usually necessary at the time of labor. Shortly after delivery the pains disappear, and when the patient is able to get about again she notices that she has become some inches shorter than previously, the diminution in stature being sometimes associated with kyphotic changes in the vertebral column.

To sum up, a history of rheumatoid pains and difficult locomotion re-

quiring rest in bed during pregnancy, associated with a decrease in height, is almost pathognomonic of osteomalacia.

**Changes in the Shape of the Pelvis.**—The extent of the deformity resulting from osteomalacia depends entirely upon the degree of softening which the various pelvic bones have undergone. According to Kehrer, in the early stages of the disease the pelvis is simply flattened as the result of the forcing downward and forward of the promontory of the sacrum.

In the later stages of the disease, when the bones have become very soft, the pelvis takes on a characteristic compressed appearance. The body weight presses the promontory still further downward and forward, while the upward and inward forces exerted by the femora push the lateral walls of the pelvis inward, so that the superior strait assumes a trefoil appear-



FIG. 564.—OSTEOMALACIC PELVIS, INFERIOR STRAIT.

ance, and in extreme cases becomes almost entirely obliterated. At the same time the ischio-pubic rami are approximated, and the pubic arch is converted into a narrow slit into which it is sometimes impossible to insinuate the fingers. The pubic rami are pushed markedly forward, giving rise to a beak-like protuberance upon the anterior wall of the pelvis. Coincident with these changes, there is a marked diminution in the size of the pelvic cavity and of the inferior strait, though in not a few cases, owing to constant sitting upon the softened bones, the tubera ischii are considerably flared out. In advanced cases the pelvis is very much deformed, and may present any one of an almost infinite variety of bizarre shapes.

**Diagnosis.**—The diagnosis is readily made, as careful inquiry will usually elicit the characteristic clinical history of the disease; while examination of the pelvis will show that it is markedly compressed in all directions, and the pathognomonic changes in the pubic arch can hardly escape detection. Indeed, the only form of pelvis with which it might be confounded is the very rare transversely contracted Robert pelvis, but the absence of the characteristic clinical history and the lack of antero-posterior shortening in the latter will usually enable one to differentiate between them.



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## CHAPTER XXXV

### ANOMALIES DUE TO ABNORMAL MALLEABILITY OF THE PELVIC BONES (*Continued*)

Marked degrees of pelvic deformity exert a pronounced influence upon the course of pregnancy as well as upon the mechanism of labor. Indeed, to be unaccompanied by more or less untoward effects the contraction must be minimal.

### EFFECT OF CONTRACTED Pelves UPON THE COURSE OF PREGNANCY

**The Position of the Uterus.**—In the early months of pregnancy a pronounced degree of pelvic malformation may interfere with the normal rising up of the uterus, particularly if the promontory of the sacrum projects so far into the superior strait as markedly to overhang the pelvic cavity. In such cases the fundus impinges upon the anterior surface of the sacrum, and as the uterus increases in size it may assume a position of more or less pronounced retroflexion, which later may give rise to characteristic symptoms of incarceration.

When the deformity is sufficient to interfere with the descent of the presenting part into the pelvis, marked abnormalities in the position of the uterus are observed in the later months of pregnancy. Under such circumstances, particularly in primiparæ, the fundus occupies a higher position than usual, and serious respiratory and circulatory disturbances often result. At the same time, owing to the fact that the lower portion of the uterus is not fixed by the engaged head, the entire organ is much more freely movable than usual.

More important, however, is the sharply anteflexed position which the uterus may assume. This is particularly the case in small women suffering from marked lumbar lordosis, in whom the capacity of the abdomen is so diminished that the growing uterus seeks to gain room by pushing forward the anterior abdominal walls. The presence of a *pendulous abdomen* is a sign of considerable importance in primiparous women, and should always cause one to suspect the existence of marked pelvic deformity. The converse, however, by no means always holds good, and its absence does not necessarily indicate that no disproportion exists. Moreover, the same condition may have no great significance in multiparous women, being generally due to a loss of tonicity of the uterine and abdominal walls as a result of previous pregnancies.

**Position and Presentation of Fœtus.**—A contracted pelvis plays an important part in the production of abnormal presentations. In primiparous women, when the pelvis is normal, the presenting part, as a rule, descends into the pelvic cavity during the last six weeks of pregnancy; but when the superior strait is considerably contracted this does not occur until after the onset of labor, and sometimes not at all. Vertex presentations still predominate; but since the head floats freely above the superior strait, or rests upon one of the iliac fossæ, very slight influences may cause the fœtus to assume other positions. According to Michaelis, vertex presentations are rarer by 10 per cent. in contracted than in normal pelves; while face, breech, and transverse presentations occur 2 or 3 times, and prolapse of the cord and the extremities 4 to 6 times more frequently.

Abnormal presentations increase in frequency with the degree of contraction, as is shown by the following figures of Michaelis, Litzmann, and Schwartz:

|                             |                             |
|-----------------------------|-----------------------------|
| Conjugata vera 9.5—8.5 cm., | 93.1% vertex presentations. |
| “ “ 8.4—7.5 “               | 83.8% “ “                   |
| “ “ 7.4 cm. or less,        | 64.7% “ “                   |

Tarnier, in 1,030 cases of labor complicated by contracted pelves, observed the following incidence for the various presentations: vertex, 85.13 instead of 96 per cent.; breech, 7 instead of 3 per cent.; face, 3 instead of 0.6 per cent.; and transverse, 4.2 instead of 0.5 per cent.

As abnormal presentations occur more frequently in multiparous than in primiparous women even under favorable conditions, as might be expected, they become still more common when the pelvis is contracted. Thus, Schauta estimated that they are 3 times more frequent in the fifth than in the first pregnancy.

In primiparous women face and transverse presentations possess a peculiar significance, as their occurrence is nearly always associated with marked disproportion between the size of the head and the pelvis, so that whenever either variety is encountered one can feel certain that the head is unusually large or the pelvis abnormally small.

**Size of Fœtus.**—La Torre, Pinard, and others have stated that the children of women with abnormal pelves usually attain a larger size than usual. Pinard attributes this to the fact that the head does not become engaged during the last few weeks of pregnancy, and therefore cannot press upon the lower uterine segment, thus doing away with one of the factors predisposing to the premature termination of pregnancy. Wilcke and Riggs, after careful study, have concluded that such is not the case, but that the children, under such circumstances, are generally slightly smaller than usual. This is particularly the case with generally contracted rhachitic pelves, as such women are usually under-sized and would naturally give birth to smaller children than would larger and better formed individuals.



## CHAPTER XXXV

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### MECHANISM OF LABOR IN SIMPLE FLAT AND FLAT RHACHITIC Pelves

The possibility of the occurrence of spontaneous labor in flat pelvis depends primarily upon the degree of contraction, and, when this is not excessive, upon the following additional factors: the size, compressibility, and malleability of the foetal head, and the character of the expulsive forces. The measurements of the pelvis can be estimated with tolerable accuracy, but there are no satisfactory methods of determining in advance the size and other properties of the head, and not until labor is well advanced can one tell at all approximately what the uterus can do.

In 701 cases of labor in contracted pelvis, occurring in my clinic up to July, 1910, spontaneous delivery occurred in 74.76 per cent., and became less frequent the more marked the pelvic deformity. Thus, when the conjugata vera measured

|                 |                                  |       |
|-----------------|----------------------------------|-------|
| 10—9.6 cm.      | spontaneous delivery occurred in | 85.1% |
| 9.5—9.1 "       | " " " "                          | 78.5% |
| 9—8.6 "         | " " " "                          | 61.3% |
| 8.5—8.1 "       | " " " "                          | 37.8% |
| 8—7.5 "         | " " " "                          | 29.4% |
| 7.5 cm. or less | " " " "                          | 13.3% |

Even when delivery is effected spontaneously and without any undue delay, certain characteristic abnormalities can be observed in the mechanism of labor, by which the experienced obstetrician is enabled to diagnose the presence of a flat pelvis without resorting to pelvimetry.

Inasmuch as in the varieties of pelvis under consideration the contraction is practically limited to the anterior posterior diameter of the superior strait, while the transverse diameter remains unchanged, or may even be slightly enlarged, it is evident that the obstacle to the passage of the child's head is offered by the shortened conjugata vera; and when this measures less than 9 or 9.5 centimeters it becomes out of the question for the biparietal diameter of the head to pass through it, unless it undergoes some diminution in size. Accordingly, when engagement is occurring, the head slips to one side so as to bring the shorter bitemporal diameter in relation with the conjugata vera. As a result the long arm of the head lever becomes displaced to the side of the occiput, so that, under the influence of the uterine contractions, the anterior portion of the head descends, while the occipital portion rises up. Consequently the large fontanelle becomes more readily accessible to the examining finger on one side of the pelvis, and the small fontanelle less so on the other. At the same time, owing to the fact that the transverse diameter of the superior strait is not shortened, the head tends to accommodate itself to it, so that its long axis, as indicated by the sagittal suture, comes to lie transversely.

More characteristic still is the abnormal attitude which the head assumes when the disproportion between it and the pelvis is at all marked, when we may have what is known as an *anterior parietal presentation*. In

this the presenting part, which is the anterior parietal bone, occupies the superior strait in such a manner that the sagittal suture lies just in front of the promontory. In such circumstances the anterior shoulder is readily distinguished upon external palpation. According to the explanation generally accepted, this condition is brought about by the abnormal relation borne by the axis of the anteflexed uterus to the plane of the superior strait, as the result of which the posterior portion of the head is pressed against the promontory of the sacrum, where it becomes arrested, while its anterior portion is forced into the pelvis.

This presentation is simply an exaggeration of the so-called Naegele's obliquity, and the mechanism of descent is readily understood when we compare the passage of the head through the abnormal superior strait to the manoeuvre necessary to pass a stick of a certain length through a ring of a somewhat shorter diameter. To do so one must depress one end of the



FIG. 565.—SHOWING ANTERIOR PARIETAL PRESENTATION.



FIG. 566.—SHOWING THE PASSAGE OF AN ANTERIOR PARIETAL PRESENTATION THROUGH THE SUPERIOR STRAIT.

stick so as to allow it to enter the ring obliquely, and after it has partially passed through its other end will descend without difficulty. Sellheim suggests that this presentation provides a mechanism for effecting a diminution in the transverse diameter of the head. He considers that the sutures are so arranged that one lateral half of the head can be displaced to some extent beyond the other, just as in pushing one half of an oval beyond its fellow the greatest transverse diameter will become considerably diminished.

In order for descent of the head to occur, the posterior parietal bone is firmly pressed against the promontory of the sacrum, while under the influence of the uterine contractions the anterior portion of the head is slowly forced down into the pelvis along the posterior surface of the symphysis pubis; after this is accomplished the posterior portion passes over the promontory and enters the pelvis, the sagittal suture at the same time moving forward. Accordingly, when the contraction is marked, the posterior portion of the head must be subjected to considerable pressure, as is demonstrated by the presence of a more or less well-defined curved depression, just behind the coronal suture, upon the side of the head which was in



contact with the promontory. After the posterior parietal bone has passed the superior strait, all resistance has been overcome, and, owing to the fact that the lower portion of the pelvis is often larger than usual, the rest of the labor is promptly accomplished.

In about one-fourth of the cases, according to Litzmann, the reverse condition—the *posterior parietal presentation*—is observed. The sagittal



FIG. 567.—SHOWING POSTERIOR PARIETAL PRESENTATION.



FIG. 568.—SHOWING THE PASSAGE OF A POSTERIOR PARIETAL PRESENTATION THROUGH SUPERIOR STRAIT.

suture now lies almost in contact with the symphysis pubis, while the posterior parietal bone occupies the superior strait, and in marked cases the posterior ear of the child can be felt just above the promontory, so that the condition is sometimes spoken of as an *ear presentation*. The long axis of the child's body forms an obtuse angle with its head, and upon palpation the anterior portion of the latter can be felt as a prominent tumor lying above the symphysis.



FIG. 569.—ENGAGEMENT OF HEAD IN RENIFORM SUPERIOR STRAIT (Tarnier).

descends along the symphysis pubis, while at the same time the sagittal suture approaches the mid-line of the pelvis. After this has occurred labor takes place in the usual manner.

The mode of production of this abnormality is not definitely understood, although it is observed most frequently when the grade of contraction is marked, the pelvic inclination considerably increased, and the abdomen

In order for the head to enter the pelvis its posterior portion must be pushed down past the promontory of the sacrum, after which its anterior portion de-

not pendulous. The presentation is generally considered as very unfavorable by the Germans, as the line along which the uterine contractions are transmitted is given another direction at the neck, which is much less advantageous than when the spinal column and head form a continuous axis. Tarnier and Varnier, on the other hand, hold that the posterior parietal presentation occurs much more frequently than the anterior, and is without ominous prognostic significance. In my experience, however, it has occurred far less frequently than the anterior variety, although in many cases it has not been associated with a particularly difficult labor.

When the promontory of the sacrum protrudes into the superior strait in such a way as to render it reniform in outline, it is impossible for the head to assume its usual transverse position, and the sagittal suture must occupy an oblique diameter (Fig. 569). In rare instances the promontory may project so far forward as to make the superior strait resemble the figure 8. Under such circumstances only one side of it is available for the passage of the head, and Breisky has designated the condition as *extra-median engagement*. Naturally, either of these conditions serves to exaggerate the degree of disproportion.

When the pelvic contraction is complicated by the existence of a face presentation, the prognosis becomes more dubious, as it is more difficult for the face than for the vertex to pass the contracted superior strait, and accordingly the course of labor is unduly prolonged.

Breech presentations likewise complicate matters to some extent, as the imperfect adaptation of the breech to the superior strait frequently facilitates prolapse of the cord or of one or more of the extremities. In such circumstances, although the prognosis for the mother remains favorable, the child's life is endangered. This is especially true when the contraction is marked, as considerable difficulty may be experienced in extracting the after-coming head, which, in passing through the contracted superior strait, follows a mechanism analogous to that observed in anterior parietal presentations. In other words, its posterior portion is arrested at the promontory, while its anterior portion passes down behind the symphysis, after which its posterior portion descends.



FIG. 570.—SHOWING PASSAGE OF AFTER-COMING HEAD THROUGH SUPERIOR STRAIT; DARKER CHILD LAST.

#### MECHANISM OF LABOR IN GENERALLY CONTRACTED FLAT AND GENERALLY EQUALLY CONTRACTED RHA-CHITIC PELTS

The mechanism of labor in generally contracted flat pelvis varies according to the extent of the deformity and the shape of the pelvis—that is, according as it approaches more closely to the flat or to the generally con-



tracted type. In the former case, provided the contraction be not too marked, the mechanism of labor will be identical with that just described for flat pelvis, whereas in the latter the head will become sharply flexed and be born by the mechanism which we shall consider in detail when we study the generally contracted or justo-minor pelvis.

In the generally and equally contracted rhachitic pelvis the mechanism corresponds to that observed in the justo-minor pelvis; while in the pseudo-osteomalacic forms the contraction is usually so marked that the child cannot be born *per vias naturales*.

### COURSE OF LABOR IN CONTRACTED PELVES

When the pelvic deformity is sufficiently marked to prevent the head from entering the superior strait during the last few weeks of pregnancy, or at the onset of uterine contractions, the course of labor is usually unduly prolonged. In the first stage this is due to imperfect dilatation of the cervix, and in the second to the time required to so mold and configure the head as to render possible its entrance into the pelvic cavity.

**Abnormalities in Dilatation of Cervix.**—Normally, dilatation of the cervix is brought about by the unruptured membranes acting as a hydrostatic wedge, and after their rupture by the direct action of the presenting part. In contracted pelvis, on the other hand, when the head is arrested at the superior strait, the entire force exerted by the uterus acts directly upon the portion of membranes in contact with the internal os, and consequently, as its force is not broken by the intervening head, as in normal labor, *premature rupture* frequently results, occurring, according to Litzmann, in 26 per cent. of the cases.

After rupture of the membranes, further dilatation cannot take place until the presenting part is able to exert a direct pressure upon the cervix, and this is out of the question until a long succession of strong pains have molded the head sufficiently to permit its descent, or have led to the formation of a *caput succedaneum* upon its most dependent portion.

Even after the cervix is completely dilated considerable delay may occur, and it sometimes requires hours to mold the head to the pelvis. In flat pelvis the labor is promptly terminated as soon as the contracted superior strait is passed, but in the generally contracted varieties this is not the case, inasmuch as the hindrance persists throughout the entire pelvic canal.

**Abnormalities in Uterine Contractions.**—Frequently the course of labor is still further prolonged owing to faulty uterine contractions. This is rarely the case in rhachitic primiparæ, in whom the pains are usually very efficient; but in multiparæ, in which previous difficult labors have weakened the uterine musculature, secondary uterine inertia frequently occurs as the result of exhaustion.

Occasionally the uterus, instead of presenting signs of secondary inertia, may become *tetanically contracted*. This is an extremely serious condition, as it cannot lead to the termination of labor, and at the same time markedly increases the danger of uterine rupture. If this complication does not yield

promptly to the administration of sedatives, it affords an imperative indication for the termination of labor by one means or another.

**Danger of Uterine Rupture.**—Abnormal thinning of the lower uterine segment frequently constitutes a very serious danger. When the disproportion between the head and the pelvis is so pronounced that engagement does not occur, the lower uterine segment becomes markedly stretched during a prolonged second stage, and the danger of rupture becomes imminent. In such cases the contraction ring can be felt as a transverse or oblique ridge extending across the uterus somewhere between the symphysis and the umbilicus, and occasionally at the level of the latter, while sometimes its position is clearly visible. Thinning of the lower uterine segment is particularly liable to occur in the generally contracted variety of rachitic pelvis, since the lower end of the cervix may be caught between the child's head and the pelvic brim, and thus be prevented from retracting. Whenever this condition is noted prompt delivery is urgently indicated; but at the same time great caution is necessary on the part of the physician lest his manœuvres give rise to traumatic rupture.

**Production of Fistulæ.**—When the presenting part is firmly wedged into the superior strait, but makes no advance for a long time, portions of the generative tract lying between it and the pelvic wall may be subjected to undue pressure. As a result the circulation is interfered with and necrosis follows, which may manifest itself a few days after labor by the appearance of vesico-vaginal, vesico-cervical, or recto-vaginal fistulæ, depending upon the part involved. These conditions are not to be feared so long as the membranes remain intact, but are liable to follow a very prolonged second stage.

**Intra-partum Infection.**—Infection is another serious danger to which the patient is exposed in prolonged labors complicated by contracted pelvis, particularly when examined repeatedly by a physician who does not observe the most stringent aseptic technique. If the amniotic fluid becomes infected, febrile symptoms appear during labor, while in other cases the micro-organisms pass through the fetal membranes and invade the uterine walls, giving rise to the characteristic manifestations of infection during the puerperium.

In other instances gas-producing bacteria may be introduced into the uterus, which soon becomes distended with gas as a result of their activity—*tympanites uteri* or *physometra*. This condition usually follows infection with *bacillus aerogenes capsulatus*, particularly when the child is dead. It was formerly attributed to the entrance of air into the uterus, but at present such an explanation must be regarded with skepticism. For further details the reader is referred to the chapter upon Puerperal Infection.

**Rupture of the Pelvic Joints.**—In rare instances, particularly when the pelvis is contracted in its lower portion, spontaneous rupture of the symphysis pubis or of one or both sacro-iliac joints has been observed. Such cases have been reported by Ahlfeld, Schauta, Braun-Fernwald, De Lee, Mayer, and others, though in the majority the injury is produced by injudicious methods of delivery.

**Effect of Labor upon the Child.**—So long as the membranes remain



intact the child suffers but little from the prolonged labor; but after their rupture, frequent and prolonged uterine contractions exert a deleterious influence upon it. This is due in great part to interference with the placental circulation, which sooner or later leads to manifestations of asphyxiation. Now and again premature separation of the placenta occurs, causing certain death to the child.

After the membranes have ruptured, and particularly during the second stage of labor, prolonged pressure exerted upon the head is not without influence upon the child, in some cases leading to vagus stimulation with its resulting slow pulse and consequent gradual asphyxiation.

**Prolapse of the Cord.**—A much more serious and frequent complication for the child is prolapse of the cord, the occurrence of which is facilitated by imperfect adaptation between the presenting part and the pelvic inlet. The condition exerts no influence upon the course of labor, but in the majority of cases death of the child results from compression of the cord between the presenting part and the pelvic wall, unless prompt delivery can be accomplished. This must be regarded as one of the most frequent causes of foetal death in spontaneous labor in contracted pelves.

**Changes in Scalp and Skull.**—As has already been stated, a marked caput is frequently developed upon the most dependent part of the head, and allusion has been made to the part which it sometimes plays in the dilatation of the cervix. In many instances it may assume very considerable proportions, but is without significance so far as the life of the child is concerned, usually disappearing within a few days after birth. When well marked it may lead to serious diagnostic errors, as it may project almost to the pelvic floor while the head is still above the brim, so that an inexperienced physician may mistake it for the head and thus be tempted to resort to ill-timed operative measures.



FIG. 571.—SHOWING MOLDING OF HEAD IN A GENERALLY CONTRACTED RHACHITIC PELVIS.

When the disproportion between the size of the head and the pelvis is considerable, it is apparent that the former can only pass through after a process of molding and accommodation, which is usually spoken of as *configuration*. In exceptional cases the head may descend into the pelvic cavity comparatively early in pregnancy, and as it cannot readily escape it undergoes further development in that position, and in consequence presents characteristic deformities at birth, the part within the pelvis being markedly flattened, while that above is unusually large, as shown in Fig. 571.

Under the influence of the strong uterine contractions the various bones comprising the skull come to overlap one another at the various sutures. As a rule the median margin of the parietal bone, which is in contact with the promontory, becomes overlapped by that of its fellow, and the same occurs with the frontal bones. The occipital bone, on the

other hand, becomes shoved under the parietal bones, so that the posterior margins of the latter frequently overlap it. These changes are usually accomplished without detriment to the child, though when the distortion is marked they occasionally lead to rupture of the longitudinal sinus, followed by fatal hæmorrhage.



FIG. 572.—OVERLAPPING OF BONES OF SKULL (Tarnier).



FIG. 573.—OVERLAPPING OF BONES OF SKULL (Tarnier)

At the same time the head also becomes molded, and the parietal bone which was in contact with the promontory, usually shows signs of having been subjected to marked pressure, sometimes becoming very much flattened. This process is more readily accomplished when the bones of the head are imperfectly ossified, in rare instances the skull being so soft that it yields to pressure as readily as the shell of a soft crab. This property is of marked importance, and serves to explain the difference in the course of labor in two apparently similar cases in which the pelvis and the head present identical measurements. In the one the head is soft and readily molded, so that spontaneous labor can result; in the other the more resistant head retains its original shape, and a radical operative procedure becomes necessary for its delivery.

Reference has already been made to the *pressure marks* upon the scalp covering the portion of the head which passes over the promontory of the sacrum. These are frequently very characteristic in appearance, and from their location enable one to determine the movements which the head has undergone in passing through the superior strait. Much more rarely similar marks appear on the portion of the head which has been in contact with the symphysis pubis. These marks have no influence upon the well-being of the child, and usually disappear a few days after birth, although in



FIG. 574.—CHILD BORN SPONTANEOUSLY THROUGH GENERALLY CONTRACTED RHECHITIC PELVIS, CONJUGATA VERA 7.25 CENTIMETERS, SHOWING CAPUT SUCCEDANEUM AND DEPRESSION OF SKULL.



exceptional instances the pressure may have been so severe as to lead to necrosis and sloughing of the scalp.

In a small number of cases *fractures of the skull* are met with. This accident usually follows violent attempts at delivery, though occasionally it may occur spontaneously. These fractures are of two varieties, appearing either as a shallow gutter-like groove or as a spoon-shaped depression just posterior to the coronal suture. The former is relatively common, and as it involves only the external plate of the bone is not very dangerous; whereas the latter, if not operated upon, leads to the death of the child in about 50



FIG. 575.—PRESSURE MARKS FROM PROMONTORY.



FIG. 576.—SPOON-SHAPED FRACTURE OF SKULL (Tarnier).

per cent. of the cases, since it extends through the entire thickness of the skull and gives rise to projections upon its interior, which exert injurious pressure upon the brain. In such cases it is advisable, as soon as convenient after labor, to elevate or remove the depressed portion of the skull, as may be indicated, in the hope of preventing the occurrence of pressure symptoms.

**Prognosis for the Mother.**—The prognosis as to the outcome of labor complicated by contracted pelvis depends not only upon the degree of contraction, but also upon the other factors to which we have already alluded. It may be said, however, that spontaneous birth of a fully developed child cannot occur when the conjugata vera measures 7 centimeters or less, and is very unlikely when it measures 7.5 cm. Above the latter limit it becomes more and more frequent the less marked the pelvic distortion.

In our series of 701 cases studied in 1910, not including funnel pelvises, 74.76 per cent. of the children were born spontaneously, and the incidence increased to 81.75 per cent. when the deliveries by low forceps were deducted, in which the operation had naturally no connection with the pelvic deformity. These results compare very favorably with those of other investigators, as is shown by the following figures:

|               |                |              |                |
|---------------|----------------|--------------|----------------|
| Valency ..... | 69 per cent.   | Bürger ..... | 77.8 per cent. |
| Peham .....   | 72.4 per cent. | Krönig ..... | 78.5 per cent. |
| Bar .....     | 76.5 per cent. | Baisch ..... | 80 per cent.   |

The probability of spontaneous labor decreases rapidly with the degree

of pelvic contraction, as is shown by the following analysis of my cases, in which the third column gives the total incidence, and the fourth column the corrected incidence obtained by deducting all operations not due to pelvic indications:

| CONJUGATA VERA<br>(Obtained by deducting 1.5 cm.<br>from Diagonal Conjugata) | NUMBER<br>OF<br>CASES | SPONTANEOUS<br>LABOR,<br>GROSS | SPONTANEOUS<br>LABOR,<br>CORRECTED |
|------------------------------------------------------------------------------|-----------------------|--------------------------------|------------------------------------|
| 10 -9.6 cm.....                                                              | 248                   | 85.1%                          | 94. %                              |
| 9.5-9.1 cm.....                                                              | 270                   | 78.5%                          | 84.3%                              |
| 9 -8.6 cm.....                                                               | 111                   | 61.3%                          | 67.6%                              |
| 8.5-8.1 cm.....                                                              | 37                    | 37.8%                          | 37.8%                              |
| 8 -7.6 cm.....                                                               | 17                    | 29.4%                          | 29.4%                              |
| 7.5 cm. or less.....                                                         | 15                    | 13.3%                          | 20. %                              |

Furthermore, if we calculate the length of the conjugata vera by deducting 2, instead of 1.5, centimeters from the diagonal conjugate, as is done by most other authorities, our results appear still more favorably, as is shown by the following tabulation:

| CONJUGATA VERA       | BÜRGER<br>IN<br>5,288 CASES | PEHAM<br>IN<br>885 CASES | BAISCH<br>IN<br>927 CASES | WILLIAMS<br>IN<br>701 CASES |
|----------------------|-----------------------------|--------------------------|---------------------------|-----------------------------|
| 10 -9.6 cm.....      | 89 %                        | 89 %                     | 94 %                      | .. %                        |
| 9.5-8.6 cm.....      | 80 %                        | 80.5%                    | 90 %                      | 89.8%                       |
| 8.5-7.6 cm.....      | 54.4%                       | 63.8%                    | 65 %                      | 60.1%                       |
| 7.5 cm. or less..... | 9.9%                        | 14.8%                    | 18 %                      | 25 %                        |

Generally speaking, the probability of spontaneous labor is somewhat less in generally contracted than in flat pelves presenting the same conjugata vera, it being customary to calculate that half a centimeter must be added to the conjugata vera of the former to reduce it to terms of the latter. This, however, is denied by Baisch, and, in my own experience, the expected difficulty is usually compensated for by the somewhat smaller size of the children.

The danger to the mother depends upon the course of labor, the perfection with which aseptic technique is observed, and the treatment pursued in operative cases. Speaking broadly, the maternal mortality after spontaneous labor should be hardly greater than that observed in normal pelves, if the case is conducted properly. On the other hand, if spontaneous labor does not occur, and the patient is left to herself, she will die undelivered, either from hæmorrhage resulting from uterine rupture or from infection. In operative cases the prognosis depends entirely upon the choice of the operation, the surroundings of the patient, and the degree of perfection of the technique.

In our 701 cases of labor complicated by contracted pelves there were



11 maternal deaths (1.57 per cent.). It should be said, however, that 4 of these patients were profoundly infected when first seen, as the result of attempts at delivery outside of the hospital, and cultures taken from the uterine cavity at the time of delivery demonstrated the presence of the micro-organisms which caused the fatal infection, leaving a net mortality of 1.0 per cent.

Bar had one maternal death in 166 cases and Baisch four deaths in 809 cases, a mortality of 0.59 and 0.50 per cent. respectively. Ludwig and Savor reported a mortality of 0.8 per cent. in 706 cases of spontaneous labor complicated by contracted pelves, as compared with 5.2 per cent. in 591 operative cases. These results were obtained within the last few years—after the perfection of aseptic technique; previously they were impossible, as Michaelis, and Litzmann reported a mortality of 10 per cent. and 7.3 per cent., respectively.

A very instructive comparison between the conditions existing then and now was furnished by Tarnier, who stated that the maternal mortality was 22 per cent. in 334 cases occurring in the Maternité in Paris between the years 1860 and 1869, as compared with 1.91 per cent. in 1,036 cases occurring between 1884 and 1892. In the latter series 764 labors were spontaneous, with a mortality of 0.78 per cent., and 272 were operative with a mortality of 5.15 per cent.

**Prognosis for the Child.**—The prognosis for the foetus is always more serious in contracted than in normal pelves, even though labor occurs spontaneously. It likewise depends to a great extent upon the methods chosen for delivery; and, broadly speaking, it may be said that the foetal mortality increases with the degree of pelvic contraction, unless Cæsarean section or pubiotomy is frequently performed. This is clearly shown by the following table of Michaelis, Litzmann, and Schwartz:

|                |               |                  |       |
|----------------|---------------|------------------|-------|
| Conjugata vera | 9.25—8.5 cm., | foetal mortality | 5%    |
| “ “            | 8.4 —7.5 “ “  | “ “              | 16.9% |
| “ “            | 7.4 —7 “ “    | “ “              | 52.9% |

According to Ludwig and Savor, the mortality was 9.4 per cent. in 706 spontaneous, as compared with 46.3 per cent. in 591 operative labors; while Bar, and Baisch reported a mortality of 11 and 23 per cent., and of 3.3 and 29.8 per cent., respectively, in two similar series of cases. The difference between the results obtained is due to the fact that Ludwig and Savor resorted to craniotomy in the difficult cases, while Bar and Baisch performed Cæsarean section or pubiotomy whenever indicated.

In our series of 701 cases, 68 children were born dead or died within two weeks after delivery, a gross mortality of 9.7 per cent. As 12 of them were macerated and 21 others died from various conditions not connected with the pelvis, the actual number succumbing to the pelvic complication was 35. Of these 7 were dead when the mother was admitted to the hospital, having succumbed as the result of operative measures undertaken outside, leaving 28, or 4 per cent., who died in our hands, as compared with Baisch's corrected mortality of 4.5 per cent.

### TREATMENT OF LABOR COMPLICATED BY CONTRACTED Pelves

The treatment of labor complicated by contracted pelves varies according to the degree of contraction, the size of the child, and the history of previous labors. Generally speaking, a normally developed full-term child cannot be born spontaneously when the conjugata vera measures 7 centimeters or less, and only exceptionally when it falls below 7.5 centimeters; whereas, interference is rarely required when it measures 9 centimeters or more.

We have therefore to consider in the first place the treatment of two great groups of pelvic deformities—those below and those above the limits just mentioned. In the first group the problem is comparatively simple, whereas in the latter it is oftentimes extremely complex and requires the utmost nicety of judgment for its proper solution.

**Conjugata Vera of 7.5 Centimeters or Less.**—It is customary to differentiate between the flat and generally contracted pelvis, and to consider that a conjugata vera of a certain length in the former gives rise to the same degree of dystocia as one a half centimeter longer in the latter. Accordingly, a flat pelvis of 7 centimeters is usually considered as equivalent to a generally contracted one of 7.5 centimeters; but as, in my experience, this is usually not the case, I shall group both types together.

When the conjugata vera falls below 7.5 centimeters the treatment will vary according as the child is alive or dead, as well as upon the physical condition of the mother and her surroundings.

If the deformity be diagnosed during pregnancy, the patient should be sent to a well-regulated hospital for the performance of Cæsarean section within a few days of the expected date of confinement or at the onset of labor, as the operator deems best. Such a procedure will give almost ideal results, and all of the children and nearly all of the mothers should be saved, inasmuch as the maternal mortality following Cæsarean section, when performed upon healthy women by competent operators at an appointed time, need hardly exceed that following the removal of ovarian cystomata.

On the other hand, if the condition of the pelvis is not diagnosed until the woman is well advanced in labor, the treatment to be pursued will vary with circumstances. If the patient is uninfected, has not been examined repeatedly by the vagina, and is among suitable surroundings, Cæsarean section will offer every prospect for saving both her and the child, provided the latter is in good condition. But if the patient is infected or in poor condition, or the child is dead or dying, the line of treatment to be pursued will be determined by the degree of pelvic contraction. If the conjugata vera be above 5.5 centimeters, craniotomy should be performed; but with a measurement below this limit we have to deal with the *absolute indication* for Cæsarean section, which should be performed, no matter what the condition of the child or the mother, as in such circumstances the delivery of a mutilated child through the natural passages will be impossible, or at least quite as dangerous to the mother as a Cæsarean section,



done under unsatisfactory conditions. In infected cases the delivery of the child should be followed by a total hysterectomy, whereas the classical conservative operation should be chosen if the patient is in good condition. Pubiotomy should not be thought of here, as its field of usefulness is limited to those cases in which the conjugata vera measures more than 7 centimeters.

**Conjugata Vera above 7.5 Centimeters.**—Here the question as to the proper treatment cannot be so readily disposed of, since definite rules cannot be laid down for the entire group, and each case must be considered upon its own merits.

We know in general that spontaneous labor will occur in many of these cases, and that its probability increases markedly with each half centimeter's increase in length of the conjugata vera. But at the same time it is very difficult to predict what will occur in an individual case, as we have to reckon not only with the degree of pelvic deformity, but also with the size of the child's head, the extent to which it may become molded and compressed, and the character of the labor pains. Moreover, although we can determine the size of the pelvis with tolerable accuracy, unfortunately we can form only a very imperfect estimate concerning the other factors; and until some method is devised by which this becomes possible, the treatment of labor complicated by moderate degrees of contraction will remain a very difficult problem.

**Methods of Determining the Size of the Head.**—Despite the existence of numerous methods devised for accurately determining the size of the head, we are still without one that is thoroughly satisfactory.

In multiparous women, important information can occasionally be gained from the character of the heads of the children born in previous labors; and if they were large and firmly ossified, it is extremely probable that the child in question will possess a head showing similar characteristics, which may even be somewhat larger, as it is well known that the size is liable to increase with the age of the mother.

Again, in some instances, *Müller's method of impression* may afford material aid. In this procedure, the patient having been anesthetized, the obstetrician seizes the brow and occiput of the child with his fingers through the abdominal wall and makes firm pressure downward in the axis of the superior strait, the effect of which may be controlled by the fingers of an assistant in the vagina. If there be no disproportion, the head will readily enter the pelvis and spontaneous labor may be predicted. On the other hand, the fact that the head cannot be forced into the superior strait does not necessarily indicate that spontaneous labor is out of the question, as we have no means of foretelling the extent to which molding and configuration will occur at the time of labor.

Munro Kerr employs the following method, which has the advantage of not requiring the services of an assistant. The obstetrician takes the Pawlik grip of the foetal head with his right hand and presses it into the pelvis; while, with two fingers of the left hand in the vagina, he feels how the head engages. At the same time the thumb of the left hand feels along the brim and estimates the degree of overlapping.

In Pinard's *palper mensurateur*, the brow and occiput having been grasped by the two hands, the head is moved from side to side, so as to bring it into close contact with the pelvic brim. When this is accomplished, one hand is placed upon the child's neck and the head pushed strongly downward and backward so as to bring its posterior portion into close contact with the promontory. An attempt is then made to insinuate the fingers of the other hand between the anterior surface of the head and the symphysis. If this can be done it indicates that there is no disproportion; but if it is impossible, and the anterior portion of the head forms a prominent tumor over the symphysis pubis, the probabilities are that engagement will not occur.

Ahlfeld believes that the biparietal diameter of the head bears a definite relation to the length of the child, and suggested attempting to measure the latter *in utero*. To do this, one blade of the pelvimeter is placed upon the abdomen over the breech of the child, while the other is introduced into the vagina and applied to the vertex. The measurement thus obtained is taken to represent one half the length of the child, and from this the size of the head is calculated, as shown by the following table:

|             |              |                     |          |
|-------------|--------------|---------------------|----------|
| For a child | 50 cm. long, | biparietal diameter | 9.06 cm. |
| " "         | 49 " "       | " "                 | 8.72 "   |
| " "         | 48 " "       | " "                 | 8.56 "   |
| " "         | 47 " "       | " "                 | 8.44 "   |
| " "         | 46 " "       | " "                 | 8.34 "   |

These figures, however, represent only the average obtained from the measurements of a number of children, but do not necessarily hold good for any given case.

Perret, in 1899, and McDonald, in 1906, recommended measuring the fronto-occipital diameter of the head through the abdominal walls, and then estimating from it the length of the biparietal diameter. Perret devised a special cephalometer for the purpose, while McDonald attaches the tips of an ordinary pelvimeter to the index and second fingers by means of strips of adhesive plaster. The former estimates the length of the biparietal by subtracting 2.5 centimeters from the measurement so obtained, while the latter contends that the amount to be subtracted averages 2.33 centimeters, but varies according to the length of the fronto-occipital diameter, as shown by the following table:

|                           |                 |                  |
|---------------------------|-----------------|------------------|
| Fronto-occipital diameter | 10.00, subtract | 1 centimeter     |
| " "                       | 10.50, "        | 1.55 centimeters |
| " "                       | 10.75, "        | 1.81 "           |
| " "                       | 11.00, "        | 1.91 "           |
| " "                       | 11.25, "        | 2.07 "           |
| " "                       | 11.50, "        | 2.26 "           |
| " "                       | 11.75, "        | 2.50 "           |
| " "                       | 12.00, "        | 2.30 "           |
| " "                       | 12.25, "        | 2.35 "           |
| " "                       | 12.50, "        | 2.50 "           |
| " "                       | 12.75, "        | 3.12 "           |



## ABNORMALITIES DUE TO MALLEABILITY OF PELVIC BONES

All of these methods may be employed during pregnancy or at the time of labor, and frequently give us valuable information. But at the same time they afford no indication as to the consistency of the head or of the extent to which it may become molded. Accurate information as to this

point can be gained only by watching the course of labor during the second stage. In many cases a fairly correct estimate may be arrived at by anæsthetizing the patient soon after complete dilatation has taken place, and carefully examining the head with the entire hand in the vagina, aided, if necessary, by pressure from above.

For convenience in considering the treatment in this class of pelvic deformities, it is advisable to subdivide them into two groups. In the first the conjugata vera varies from 10 to 9 centimeters; while in the second group it varies from 9 to 7.5 centimeters.

**Conjugata Vera from 10 to 9 Centimeters.**—Spontaneous labor is the rule in pelvises belonging in this category, unless the head is unusually large or the expulsive forces are very deficient, since a moderate-sized head will usually become molded sufficiently to pass through the contracted superior strait. Accordingly, in pelvises of this character the course of labor should be left to Nature as long as possible,



FIG. 577.—WALCHER'S HANGING POSITION (Bummin).

and interference resorted to only when absolutely necessary. In most cases the head becomes engaged and generally descends into the pelvis after an hour or so of second-stage pains, or at least becomes sufficiently molded to permit the safe application of high or mid forceps.

On the other hand, if engagement fails to occur after complete dilatation of the cervix, the patient should be placed in Walcher's position for as long a time as she will bear it. In many cases this procedure will bring about a lengthening of the antero-posterior diameter of the superior strait sufficient to permit engagement. As soon as the head has descended into the pelvis, the patient should be placed upon her back, as the hanging position tends to contract the pelvic outlet and thus retards delivery. If this does not bring about the desired result, or the child is unusually large, the treatment outlined in the following section should be adopted.

If the child should die during the course of labor, craniotomy should

be resorted to without hesitation, as it is far safer for the mother than the application of high forceps.

**Conjugata Vera 9 to 7.5 Centimeters**—It is in "border line" pelves contracted within these limits that the greatest difficulty is experienced in predicting the course of labor and in laying down rules for treatment. More than one half of the patients will be delivered spontaneously, the number decreasing as the lower limit is approached; but at the same time it is impossible to foretell what will occur in a given case. Accordingly, the labor should be left to Nature as far as possible, in the hope that spontaneous delivery will result. If, however, the history of previous labors or the excessive size of the child's head renders it almost certain that such a termination is out of the question, Cæsarean section should be performed at an appointed time at the end of pregnancy. Whenever a tentative course is pursued, the most rigorous aseptic technique should be employed, and the progress of labor followed by external palpation, internal examination being restricted as far as possible. If the condition of the pelvis has been ascertained before labor, a vaginal examination need not be made until after rupture of the membranes, as there is no possibility of the head descending before its occurrence. The foetal heart, of course, should be auscultated at frequent intervals.

In a large number of cases spontaneous delivery will occur after a longer or shorter second stage; but if the head shows no tendency to descend after several hours of efficient second-stage pains, a spontaneous termination can scarcely be hoped for, and it then remains to determine what will be the most desirable method of delivery.

If the patient is in a well-regulated hospital, or can be surrounded by every convenience in her own home, the second stage of labor should be allowed to go on for one or two hours before the internal examination is made. If at that time the head is found to be well molded but still above the superior strait, and shows no sign of engaging, the pains having been efficient, pubiotomy or Cæsarean section should be considered, according to the preference of the operator; although my experience leads me to believe that in such circumstances the former is preferable. The necessary preparations for the operation should then be made and the patient anæsthetized. But before proceeding to operate, a thorough vaginal examination should be made with the entire hand, and the size and character of the head estimated. If there seems to be no likelihood of engagement occurring, the operation should be proceeded with, but in other cases it should be deferred.

On the other hand, if the patient be in a tenement house and refuses to enter a hospital, or is in the country where the physician cannot command the necessary assistance and appliances for an aseptic operation, the second stage should be allowed to continue until the appearance of definite signs of danger on the part of the mother or child. Occasionally spontaneous labor will occur contrary to all expectation. Failing such a fortunate outcome, high forceps should be applied obliquely to the head and a few tractions made. If the head shows a tendency to advance, they should be persisted in, but if not, the instrument should be removed and crani-



otomy performed at once. In such cases forceps should be employed only *tentatively*, it being understood that their employment is generally contra-indicated, and that prolonged traction and brutal methods of extraction are not permissible, as by their means the child is almost as surely lost as by craniotomy, while the life of the mother is unnecessarily endangered.

Of course, if the patient is a devout Catholic, the well-known views of that Church concerning craniotomy must be recognized, and the physician may feel called upon to perform pubiotomy or Cæsarean section when, from a purely professional point of view, its justifiability might be open to criticism. In all grades of moderately contracted pelvis craniotomy should always be performed if the child has died during the course of labor, as any other operation subjects the mother to increased danger for the purely sentimental consideration of not mutilating the child.

Furthermore, if the patient has not been seen until far advanced in labor, and has been repeatedly examined by persons not skilled in aseptic technique, or if she presents symptoms indicative of a beginning infection, pubiotomy or Cæsarean section is contra-indicated on account of their very high mortality in such circumstances. Tentative attempts at delivery with forceps should be made, and if these fail craniotomy should be performed unless the patient is very anxious for a living child and is willing to undergo the markedly increased risks of Cæsarean section after these have been clearly set before her and her family. In such cases the entire uterus should be removed. Not a few authorities advise pubiotomy under these conditions, but in my opinion the results obtained are by no means commensurate with the added risk to which the patient is subjected.

If the line of treatment which we have outlined for hospital practice be rigorously carried out, I feel sure that the foetal mortality will hardly exceed that occurring in normal labor, while the maternal mortality will be reduced to a minimum. On the other hand, when the forceps is employed tentatively and is followed by craniotomy in unsuccessful cases, the foetal mortality will approach 50 per cent., but the danger to the mother will be only slightly increased.

**Breech and Face Presentations in Contracted Pelves.**—The existence of a breech presentation in moderate degrees of pelvic deformity should be regarded as a complication especially unfavorable for the child, inasmuch as in the early stages of labor prolapse of the cord is facilitated, and in the later stages serious delay may be encountered in the extraction of the after-coming head, which is followed by almost uniformly fatal results. Accordingly, unless one feels confident that no great disproportion exists, it is advisable to lay the Gigli saw prophylactically before attempting extraction. If the head passes without difficulty, all is well, but, if not, the pubis should be sawed through, after which delivery can be readily effected. In my hands, this method of procedure has proved most satisfactory, and has given me a sense of security which was previously woefully lacking. So far as the mother is concerned, breech presentations are rather favorable, for the soft breech does not subject her soft parts to such injurious pressure as the hard head; and if delivery becomes imperative,



extraction can usually be accomplished without great difficulty, unless the pelvic contraction is very marked.

In frank breech presentations, when there is reason to believe that operative interference will become necessary and the pelvis is but slightly contracted, it is advisable, as a prophylactic measure, to bring down one foot soon after rupture of the membranes, so that prompt delivery can be effected when indicated.

Face and brow presentations should be regarded as much more serious complications, as their existence usually indicates a marked degree of disproportion and an increased probability of the necessity for operative interference. If the pelvic contraction is at all serious, too much should not be expected from Nature, and radical measures should be promptly employed. On the other hand, when one feels fairly satisfied that the disproportion is not excessive and can be overcome, an attempt should be made to convert the presentation into a vertex by one of the recognized procedures.

**Use of Forceps in Contracted Pelves.**—Generally speaking, the employment of high forceps is contra-indicated in contracted pelves, especially when the head is freely movable above the superior strait. The persistence of the condition after several hours of efficient second-stage pains generally indicates that the disproportion between the head and pelvis is too great to be overcome. In such cases forcible attempts to drag the head through the pelvis will lead to fatal injury of the child, and frequently to the death of the mother or to serious lesions on her part. Too many cases in hospital and consultation practice abundantly bear out the truth of this assertion. On the other hand, the tentative application of forceps, after the head has become well molded and is fixed at the pelvic brim, is a justifiable procedure, provided brutal traction is not made. If, however, it fails to effect delivery, the obstetrician must be prepared to resort to craniotomy, rather than to a major operation.

When the greatest circumference of the head has passed the superior strait, the employment of forceps is governed by the same rules as in normal pelves, for in such cases the operation is not performed on account of the contracted pelvis, but for one of the usual indications.

**Version in Contracted Pelves.**—Version is frequently recommended as a satisfactory method of delivery in contracted pelves, and many authorities compare its advantages with those obtained with the forceps.

Sir James Y. Simpson pointed out that the after-coming head offered more favorable conditions than the vertex for passing through the contracted superior strait, as smaller diameters are the first to encounter and overcome the resistance offered by the pelvis. But although version undoubtedly presents some advantages so far as the mother is concerned, these are more than counterbalanced by the dangers to which it exposes the child. Thus Lichtenstein states that the foetal mortality in 154 operations performed in Leopold's clinic from 1901 to 1905 was 26.62 per cent. Moreover, the advantages of version are markedly diminished by the fact that it must be performed soon after rupture of the membranes if satisfactory maternal results are to be obtained. This limits considerably its range of



usefulness, as one is compelled to operate before the uterine contractions have had an opportunity to exert their full effect in molding the head; consequently it will be impossible to subject the patient to the test of labor, so that many cases will be delivered artificially, which, if let alone, would have terminated spontaneously.

Formerly many of the German authorities recommended the performance of so-called *prophylactic version*—turning at the onset of the second stage—in all cases of moderate disproportion. This practice does not appear justifiable for several reasons. In the first place, it does away with the possibility of spontaneous labor and converts all into operative cases; and, on the other hand, when the operation is performed at the most favorable time, just after the rupture of the membranes, the head has had no chance of becoming molded, and accordingly must be dragged through the pelvis with only such diminution in size as results from a few minutes' traction. Moreover, the death of the child is inevitable if any serious obstacle to extraction is experienced, as only a few minutes can elapse between the birth of the umbilicus and the delivery of the head, and sufficient time is not available to permit of any other operation being performed in the hope of saving the child. For these reasons a mistake in the estimation of the degree of disproportion always results in foetal death.

**Induction of Premature Labor.**—In moderate degrees of pelvic deformity many authorities recommend the induction of premature labor at the thirty-fourth or thirty-sixth week of pregnancy, in the hope that the smaller and softer head will be born more readily than at term. This is undoubtedly the case, and the operation, if properly performed, should have a maternal mortality of less than 1 per cent. Personally, I have never induced labor for this indication and do not recommend the procedure. It is applicable only to the more moderate degrees of contraction, in which spontaneous labor at term is the rule; while the children frequently succumb to the operation, or, when born alive, are so imperfectly developed that even with the most careful attention hardly more than 50 per cent. survive the first year.

Sarwey, in 1906, collected 2,200 cases from 50 operators, and found that 22 per cent. of the children were born dead, and that an additional 20 per cent. of those born alive succumbed before leaving the hospital—a net mortality of 37.3 per cent. Voorhees reported, in 1905, a primary mortality of 21 per cent. from Cragin's clinic, and Norris one of 13 per cent. These results, to my mind, are not so good as those following the expectant treatment at full term, and are far inferior to those following the more general performance of pubiotomy or Cæsarean section in the class of cases under discussion. Indeed, the foetal mortality, direct and indirect, attending the induction of premature labor is so great that it appears to be merely a question of degree between its employment and bringing about artificial abortion in the early months of pregnancy.

My own experience fully confirms the conclusions of Baisch concerning the great value of expectant treatment in contracted pelvis. In his exhaustive study he clearly demonstrated that the results for the child improve according as the use of high forceps, prophylactic version, and the induction



of labor is more and more restricted, while at the same time the maternal mortality is not increased. Moreover, the employment of these operations leads to a great deal of unnecessary interference, as is clearly demonstrated by the fact that in the clinics of Fritsch, Chrobak, and Braun the percentage of spontaneous labors was 66, 54.5, and 37, respectively, as compared with the 75 or 80 per cent. observed in the hands of those employing expectant treatment.

Similar conclusions may be drawn from the consideration of the 4,500 patients in whom my 701 cases of contracted pelvis were observed. These may be divided into two groups, comprising 2,000 and 2,500 patients respectively. In the former high forceps and version were frequently employed, while in the latter labor was conducted in a much more expectant manner, and Cæsarean section or pubiotomy freely employed when radical interference was indicated, with the result that the total operative frequency fell from 32 to 21 per cent., while the gross and net foetal mortality fell from 11.3 to 8.3 per cent. and from 4.73 to 3.38 per cent., respectively. At the same time the maternal mortality was reduced nearly one half.

Accordingly, it appears that intelligent expectant treatment, while reducing the total number of operations, necessitates the more frequent employment of radical procedures, but at the same time results in a marked decrease in both foetal and maternal mortality. It should always be remembered that a spontaneous outcome may be expected in from 75 to 80 per cent. of all contracted pelves, and that radical surgical interference will be necessary in less than one half of the operative cases, and to a considerably less extent in the class of cases in which the induction of labor is advocated.

That the claims of its advocates are untenable is demonstrated by stating that equally good results could be obtained, as far as the child is concerned, by performing craniotomy in every case in which spontaneous labor does not occur, which is naturally an absurd proposition. Accordingly, it must be admitted, if the induction of labor is frequently employed, that it must in many instances be resorted to unnecessarily, and consequently cannot fail to increase materially the maternal mortality.

In conclusion, it cannot be too forcibly impressed upon the general practitioner and the student that the repeated delivery of dead children in cases of contracted pelves is absolutely unjustifiable. The loss of a child may frequently be perfectly excusable in a single pregnancy, but its repeated occurrence indicates a neglect of human life which should not be tolerated, and physicians should learn that it is their duty, if they do not feel competent to cope successfully with such cases, to send them to a well-regulated hospital or to confide them to the care of a competent specialist for appropriate treatment.

#### **TREATMENT OF LABOR COMPLICATED BY OSTEOMALACIC PELVES**

The course of labor in osteomalacic pelves varies according to the stage of the disease and the degree of contraction. When the deformity is slight



its influence upon the labor is minimal, but when marked it frequently gives an absolute indication for Cæsarean section.

Some idea of the obstacle offered to labor by this class of pelves may be gained from the figures of Litzmann, who, in 1861, collected from the literature and tabulated 79 cases. He found that the following operations had been performed: 40 Cæsarean sections, 16 perforations, 1 symphyseotomy, 2 inductions of premature labor; while 7 women had succumbed to rupture of the uterus, and 4 others had died undelivered.

Latzo, in 1897, considered the effect of osteomalacia upon the course of labor in 85 patients who came under his observation. The women in question had 459 labors, 290 of which occurred before and 169 after the appearance of the disease. In the first group operative interference was necessary once in every 48 cases, and in the second once in every 4.9 cases, thus showing that labor had become 10 times more difficult.

If the patient is seen during the early months of pregnancy and is suffering from the disease in its acute stage, she should be at once removed to a hospital where she can live under the best hygienic surroundings and be supplied with an abundance of suitable food. Phosphorus in doses of 2.4 to 4 milligrams per day in pill form or combined with cod-liver oil or almond oil should be given, as Latzo, Winckel, and others claim that many cases can be permanently cured by its administration.

On the other hand, if not seen until the end of pregnancy or the time of labor, the treatment to be pursued depends altogether upon the degree of pelvic contraction. In such cases attention should be paid not only to the length of the conjugata vera, but more particularly to the dimensions of the inferior strait, as the pelvic outlet is usually very markedly contracted.

In florid cases the bones may be so soft as to resemble leather in consistency, and the pelvis readily assumes various forms. This affords an explanation for the fact that one is occasionally surprised to see delivery accomplished through a pelvis which at first glance appears to offer no possibility of such an occurrence. Quite a number of such cases are recorded in the older literature, but such an outcome should be regarded as very exceptional, and should not lead us to expect too much of Nature.

If the pelvis is markedly contracted Cæsarean section should be performed without hesitation, followed by the removal of the uterus and ovaries, or by castration alone. Fehling has shown that either of these operations leads to the permanent cure of the disease in about 80 per cent. of the cases, and his results have been confirmed by Löhlein, Schauta, Latzo, and many other observers. On the other hand, if delivery occurs spontaneously, or has been effected by forceps or version, castration should be performed soon after the puerperium in the hope of checking the disease.

Exactly why this operation should have such a marked effect has not as yet been satisfactorily determined. As was said in the preceding chapter, Fehling considers the disease as a trophoneurosis of ovarian origin, and believes that the removal of the ovaries does away with the reflex stimulation of the vaso-dilators, which he considers plays so important a part in the production of the bone changes.

Caratulo and Tarulli made careful studies of the metabolism occurring in dogs before and after castration, and showed that the excretion of lime salts and phosphoric acids was markedly diminished after it. Hence they argue that the presence of the ovaries in some way either favors decalcification or prevents calcification of the newly formed osteoid tissue. Their conclusions, however, have been denied by Falk, and are critically considered in Christofoletti's contribution.

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## CHAPTER XXXVI

### ABNORMAL PELVES RESULTING FROM PRIMARY ANOMALIES IN DEVELOPMENT

Three separate groups of cases are differentiated according as the abnormalities are: (a) Generalized and symmetrical; (b) localized and asymmetrical; (c) localized and symmetrical.

#### I. GENERALIZED AND SYMMETRICAL ANOMALIES IN DEVELOPMENT

Abnormal development may manifest itself in an excess or in a lack of the general growth of the pelvis. In the former case we have to do with the generally enlarged or justo-major pelvis, and in the latter with one of several varieties—the generally contracted (justo-minor) pelvis, the infantile, the masculine, or the dwarf type.

**The Generally Enlarged (Justo-major) Pelvis.**—This variety of pelvis is symmetrically enlarged in all its parts, and differs from the normal only by its increased size. It is usually observed in giantesses, and occasionally in women of normal stature; indeed, if the external measurements alone are taken as a criterion, it is of quite frequent occurrence in the latter.

According to Schauta, the various diameters in this type rarely exceed the normal by more than 2 centimeters, though he refers to De la Tourette's case, in which the antero-posterior and transverse diameters of the superior and inferior straits measured 14.9 and 17, and 14.9 and 14.9 centimeters, respectively. In not a few cases the greatest increase is in the antero-posterior diameter, while the others remain practically normal. Occasionally the enlargement may be limited to the superior strait, while the lower portions of the pelvic canal retain their usual proportions, thus producing a funnel-shaped pelvis. In rare instances excessive transverse external measurements may be due to the fact that the fossæ join the main body of the iliac bones at a less obtuse angle than usual.

This variety of pelvis has no effect upon the course of labor, except that its excessive size now and again obviates the necessity for the usual mechanism, and the head may be born so rapidly and suddenly that serious perineal tears result.

**The Generally Contracted (Justo-minor) Pelvis.**—This type was first described by Deventer as the *pelvis nimis parva*, while Stein later applied to it the designation *justo-minor*. All of its measurements are more or less proportionately shortened, so that at first glance the pelvis may appear



perfectly normal, the narrowing being discovered only after careful mensuration.

As a rule, the generally contracted pelvis is lighter in texture, and its component parts are more delicately formed than usual. The sacrum is smaller, and the alæ proportionately shorter than the bodies of its vertebrae. At the same time its vertical concavity is sometimes increased. On careful examination it is found that the decrease in size is not uniform,



Fig. 578.

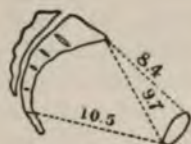


Fig. 579.

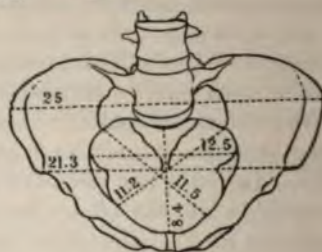


Fig. 580.

FIGS. 578-580.—GENERALLY CONTRACTED PELVIS.

as occasionally the conjugata vera is relatively shorter than the transverse diameter of the superior strait, while in every fifth or sixth specimen the inferior is relatively smaller than the superior strait, so that we have a type approaching the simple flat or funnel-shaped pelvis, respectively. Michaelis considered that the antero-posterior shortening in this class of pelvis rarely exceeds 1.5 centimeters; and, although this appears to be too conservative a figure, it may be said that whenever the conjugata vera measures 8 centimeters rachitic changes should be suspected.

This pelvis is usually met with in small women, although one is occasionally surprised to find it in those of large stature. It has generally been

said to occur but rarely in Germany and France, although it was observed in 37 and 28 per cent. of the contracted pelves reported by Müller and Gönner respectively; and Richelet states that it is much more common in France than has generally been believed. My own observations show that it is by no means unusual in Baltimore, as it was noted in 4.7 per cent. of our white, and in 21.4 per cent. of our black patients. Furthermore, it ranks second in order of frequency in the former, and is the most frequent variety of contracted pelvis in the latter, comprising 33.4 and 53.7 per cent. of all pelvic abnormalities in the two races respectively. In the colored race it is undoubtedly a sign of degeneration, and is a manifestation of the imperfect physical development which characterizes negroes living in large cities.

Müller considered that its frequency in Berne was probably due to the prevalence of cretinism in that locality, but the fact that Gönner observed it almost as frequently in Basel, where the latter disease occurs but rarely, militates against such a view. It is quite possible that not a few so-called justo-minor pelves are really of rhachitic origin, especially in negroes, and that in such cases the other more characteristic changes are lacking.



FIG. 581.—CHONDRODYSTROPHIA FETALIS.

The *diagnosis* is readily made. The existence of a generally contracted pelvis should always be suspected in small women, and especially in poorly developed working women, although it should not be forgotten that it may occur in large and apparently well-formed individuals. Accurate information can be obtained by means of pelvimetry. All of the external measurements are considerably and uniformly shortened. Internal examination shows a shortened conjugata vera, with general smallness of the pelvic cavity, typical rhachitic changes being absent. The average measurements in 36 white women in my clinic presenting pelves of this character were: Spines, 23.25; crests, 25.7; trochanters, 26.3; Baudelocque, 17.9; and diagonal conjugate, 11.1 centimeters, while in 167 colored women each measurement was a few millimeters shorter.

The effect of the generally contracted pelvis upon labor is very characteristic. Owing to the fact that all the diameters of the superior strait are shortened, instead of only the conjugata vera, as in flat pelves, the head encounters more or less equal resistance from all sides of the pelvic inlet, and consequently enters it in a sharply flexed position, so that on vaginal examination the small fontanelle is readily felt, whereas the large fontanelle is almost or quite out of reach. Moreover, as the contraction involves all portions of the pelvic canal, labor is not rapidly completed after the head has passed the superior strait, but as a rule is considerably prolonged. This is due partly to the resistance offered by the pelvis, and partly to the faulty character of the uterine contractions incident to the imperfect development of the uterus, which frequently characterizes such cases.



As has already been said, it is usually taught that a generally contracted pelvis with a conjugata vera of a given length offers a greater obstacle to labor than a flat pelvis offering a similar measurement, and for practical purposes half a centimeter is usually added to the latter to reduce it to terms of the former.

**The Masculine Pelvis.**—Michaelis directed attention to the fact that generally contracted pelvises are occasionally encountered in which the bones are thicker and clumsier than usual and approach the male type. Pelvises of this class occur less frequently than is generally believed, as many which are so described are in reality typical funnel pelvises. They have the same effect upon labor as the ordinary justo-minor variety, though in exceptional instances the relatively great contraction of the inferior strait may give rise to serious dystocia.

**The Infantile Pelvis.**—In rare instances, as the result of disease, which has caused the individual to spend her entire life in bed without attempting to sit up or walk, the pelvis retains the characteristic infantile form to which reference was made in Chapter I. Examples of this abnormality have been described by Naegele, Leisinger, Büttner, and Gurlt, but naturally it possesses no obstetrical significance.

**The Dwarf Pelvis.**—According to Breus and Kolisko, several varieties of dwarfs must be distinguished—i. e., the chondrodystrophic, the "true," the cretin, the rhachitic, and the hypoplastic dwarf.

In the first-mentioned variety the deformity results from chondrodystrophia foetalis (Kaufmann), achondroplasia (Parrot and Porak), or foetal rhachitis, as the disease has been variously designated. The affection is not allied to rhachitis, but is characterized by well-marked changes in the epiphyseal cartilages, which lead to imperfect development of the shafts of the long bones, so that the individual may present a well-formed head and body, while the extremities are short and stumpy. Herrgott has shown that the condition is sometimes hereditary, and that persons suffering from it are frequently exceptionally fertile, and thus contrast markedly with cretin dwarfs, in whom sterility is the rule.

In the "true" dwarf there is a proportionate lack of general development, which is particularly characterized by the fact that the various epiphyses do not undergo ossification, but remain cartilaginous until an advanced age.

In the *cretin dwarf* the lack of development is general. The bony



FIG. 582.—CHONDRODYSTROPHIC DWARF (Breus and Kolisko).

changes are allied to those observed in the true dwarf, but are less marked.

The term *rhachitic dwarf* should not be applied to individuals whose short stature is due to skeletal deformities, but should be restricted to those who would fall far below the normal height even if the deformities were straightened out and compensated for.

In the *hypoplastic dwarf* the changes are quantitative instead of qualitative, so that the individual differs from the normal only in her miniature appearance.

Each of these varieties of dwarfs has a characteristically shaped pelvis, which is more or less generally contracted.

*The Chondrodystrophic Dwarf Pelvis.*—Fig. 581 represents a chondrodystrophic infant, and Fig. 582 a chondrodystrophic dwarf, whose pelvis, described by Breus and Kolisko, is reproduced in Fig. 583. The woman was twenty-seven years old and 123 centimeters tall, and died after a Cæsarean section.



Fig. 583.

Fig. 584.

FIGS. 583, 584.—CHONDRODYSTROPHIC PELVIS (Breus and Kolisko).

This variety of pelvis is characterized by an extreme antero-posterior flattening, so that on first glance one might believe that one had to deal with a rhachitic pelvis. On closer examination, however, it is seen that the flattening is due to the imperfect development of the portion of the iliac bone entering into the formation of the ilio-pectineal line, owing to which the sacral articulation is brought much nearer the pubic bone than usual. In 6 pelves of this character described by Breus and Kolisko the conjugata vera varied from 4 to 7 centimeters, while the transverse diameter of the superior strait was but slightly shortened, varying from 11 to 12 centimeters.

*The True Dwarf Pelvis (Pelvis Nana).*—This variety of pelvis is extremely rare, only 4 well-marked specimens being in existence—those described by Naegele and Boeckh, Schauta, Paltauf, and Breus and Kolisko, two of which were in females. The pelvis is generally contracted and



tends toward the infantile type, but its most characteristic feature is the persistence of cartilage at all the epiphyses. Thus, in Boeckh's pelvis, which belonged to a thirty-one-year-old woman, 108 centimeters tall, the Y-shaped cartilage at the acetabulum was clearly marked and the sacral vertebrae were not fused together (Fig. 585).

*The Cretin Dwarf Pelvis.*—This is a generally contracted pelvis with poorly developed and imperfectly formed bones. Unlike that of the true dwarf, it does not present infantile characteristics, but shows signs of a steady though imperfect growth throughout early life. Unossified cartilage may be present here and there in young subjects, but it disappears with



Fig. 585.



Fig. 586.

FIGS. 585, 586.—TRUE DWARF PELVIS (Boeckh).

advancing age and is never found in all the epiphyses as in the true dwarf pelvis.

*The Rhachitic Dwarf Pelvis.*—True rhachitic dwarfs are rare, and possess generally contracted, flat rhachitic pelvises, which do not differ from those described in the previous chapter except by their extremely small size.

*The Hypoplastic Dwarf Pelvis.*—According to Breus and Kolisko this variety of pelvis is observed in very small individuals, and is simply a normal pelvis in miniature. It differs materially from that of the true dwarf in that it is completely ossified.

## II. LOCALIZED AND ASYMMETRICAL ANOMALIES IN DEVELOPMENT

*The Obliquely Contracted or Naegele Pelvis.*—Naegele, in 1803, was the first to recognize the significance of this variety of pelvis, and in 1839 published a monograph upon the subject based upon the study of 35 specimens, one of which had been obtained from an Egyptian mummy.

The Naegle pelvis presents the following characteristics: The alæ of the sacral vertebrae are either lacking or imperfectly developed upon one side, while the corresponding sacral foramina are smaller than those on the normal side. In the great majority of cases the sacrum and the innominate bone are firmly synostosed on the affected side. At the same time the latter is pushed upward and backward, as well as inward from the region of the acetabulum, and its crest is at a higher level than that of its fellow. The ilio-pectineal line is less curved than normally, being almost straight when the deformity is marked, while upon the opposite side its curvature is accentuated, particularly in the anterior portion. Corresponding with the change in position of the innominate bone, the ischial tuberosity and spine are displaced inward, upward, and backward, thereby approaching the outer margin of the sacrum and narrowing the sacro-

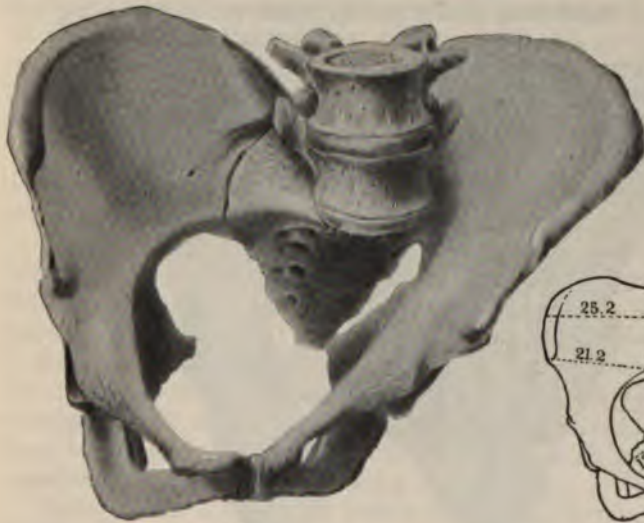


Fig. 587.

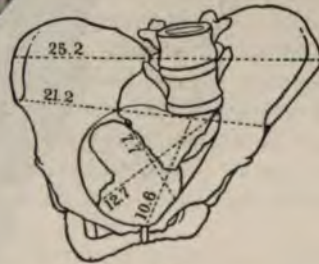


Fig. 588.

FIGS. 587, 588.—ANTERIOR VIEW OF OBLIQUELY CONTRACTED PELVIS (Naegle).

sciatic notch. The symphysis pubis is displaced toward the well side, while the pubic arch instead of looking directly forward is directed toward the abnormal side of the sacrum. The sacrum itself is displaced toward the ankylosed side, while its anterior surface is directed more or less obliquely toward it.

As a result of these changes the pelvis becomes obliquely contracted, the superior strait being ovate in shape, with its small pole directed toward the abnormal sacro-iliac joint and its larger end toward the horizontal ramus of the pubis on the well side. Its oblique diameters are of unequal length, the shorter extending from the sacro-iliac synchondrosis of the well side to the ilio-pectineal eminence on the diseased side, while the conjugata vera is usually somewhat lengthened and is directed obliquely.

The distances from the promontory of the sacrum to the acetabulum



and from the tip of the sacrum to the ischial spine are markedly diminished on the diseased side. At the same time the distance between the tuber ischii of the diseased side and the opposite posterior superior spine is less than that between the tuber ischii of the well and the corresponding spine of the diseased side. Moreover, the tip of the spinous process of the last lumbar vertebra is nearer the anterior superior spine of the ilium on the diseased than on the well side, while the distance from the lower margin of the symphysis to the posterior superior spine is less upon the well side.

The walls of the pelvis converge below, so that the contraction involves the entire pelvic cavity, but is relatively greater in the plane of least pelvic dimensions and in the inferior strait than at the superior strait. The acetabulum on the diseased side is directed more anteriorly, while that on the well side looks almost directly outward.

*Mode of Production.*—The genesis of this variety of pelvic deformity has given rise to a great deal of discussion, some writers claiming that



FIG. 250.—POSTERIOR VIEW OF OBLIQUELY CONTRACTED PELVIS (Naegele).

the defect in the sacrum is primary and the synostosis secondary; others, that the synostosis results primarily from changes which bring about more or less destruction of the sacral alæ. The former view was advocated by Hohl, Litzmann, Olshausen, and Schauta, and the latter by K. Martin, Thomas, and others.

It is generally admitted that the first-mentioned view is correct, and it has been shown that the entire sacral alæ might be lacking. Moreover, Thomas and Kundrat, among others, have stated that the alæ of one or more sacral vertebrae might be perfectly developed while the others are normal. Synostosis usually occurs at the affected sacro-iliac joint, a necessary characteristic of this variety of pelvis.

The mode in which the deformity is produced is as follows:

Owing to the asymmetry of the sacrum there is compensatory scoliosis of the lumbar portion of the vertebral column with its convexity on the diseased side. This causes the pelvis to assume an angle with the horizon, thereby bringing about a lowering of the acetabulum on the diseased side. As a consequence greater pressure is exerted by the femur on that side, which gradually brings about an upward, backward, and inward displacement of the corresponding innominate bone. Owing to the increased pressure, the synovial membrane at the sacro-iliac synchondrosis gradually undergoes pressure necrosis, and synostosis eventually results.

*Frequency.*—Thomas, in 1861, was able to collect from the literature a description of 50 pelvises of this character. Since then additional cases have been described, but at present the entire number does not exceed 100.

*Diagnosis.*—Generally speaking, the condition is readily recognizable, provided that one's attention is directed to its possible existence. Unfortunately, since the customary external measurements give no clew to its presence, the diagnosis is usually not made until labor is far advanced, when the evident dystocia forces one to look for the cause. The patients do not limp, and as a rule give no history suggestive of trouble at the sacro-iliac joint. On the other hand, the existence of scoliosis, a variation in the height of the hips, or a difference in the distance between the spine of the last lumbar vertebra and the posterior superior spine on either side should cause one to suspect its possibility.

Naegele suggested five measurements which should be made in such cases: (1) From the tuber ischii of one side to the opposite posterior superior spine; (2) from the anterior superior spine of one side to the opposite posterior superior spine; (3) from the spine of the last lumbar vertebra to the anterior superior spine on either side; (4) from the trochanter to the opposite posterior superior spine; (5) from the lower margin of the symphysis pubis to the posterior superior spines on either side. Normally, these various measurements should be the same on both sides, but differ considerably in obliquely contracted pelvises.

Owing to the difficulty of definitely locating their end points, the first, fourth, and fifth measurements are rarely employed; but the information obtained from the second and third is of very considerable value. A difference of more than 1 centimeter between these measurements on the two sides indicates an obliquely contracted pelvis, but is not sufficient to enable one to differentiate between the Naegele and the other varieties. On internal examination the conjugata vera is not shortened, but on measuring the diagonal conjugate it is found that the symphysis pubis, instead of being situated directly in front of the promontory, lies considerably to one side of it. On palpation it is found that the lateral wall of the pelvis, as well as the ischial spine and tuberosity, approaches the sacrum much more closely on the diseased than on the opposite side, while the iliopectineal line is markedly flattened. At the same time the distance between the tubera ischii is markedly diminished.

*Effect upon Labor.*—When the deformity is at all pronounced, the side of the pelvis corresponding to the small end of the oval is so contracted as to be useless for the passage of the child, so that engagement, if it is to



occur at all, must take place on the opposite side. In effect, the pelvic inlet becomes converted into one of the generally contracted variety, and an idea of its available space is gained by measuring, not the conjugata vera, but the distance between the symphysis pubis and the sacro-iliac synchondrosis on the normal side. If engagement is possible, labor will progress more favorably when the occiput is directed toward the ilio-pectineal eminence of the diseased than toward that of the well side, for the reason that in the first instance the biparietal diameter lies in the long oblique instead of in the short oblique diameter of the superior strait.

Owing to the steady increase of the contraction in the lower portion of the pelvis, marked difficulty is experienced when the head attempts to pass between the ischial spines and tuberosities, and the possibility of delivery depends upon the distance between these points.

*Prognosis.*—If the deformity is at all pronounced the prognosis is bad, unless Cæsarean section be performed. Litzmann states that 22 out of 28



Fig. 590.



Fig. 591.

FIGS. 590, 591.—TRANSVERSELY CONTRACTED ROBERT PELVIS (Robert).

mothers died in the first labor, and that only 6 labors ended spontaneously out of the 41 making up his entire series.

Generally speaking, spontaneous labor is out of the question unless the short oblique diameter measures 8.5 centimeters. When this limit is reached Cæsarean section is the only rational method of treatment if the child is alive and the patient in good condition. Pinard in one case gained sufficient room for the delivery of the child by sawing through the horizontal ramus of the pubis and the ascending ramus of the ischium on the diseased side—ischio-pubiotomy. The operation was strongly condemned by Budin, and its performance is not to be recommended, for the reason that the ankylosis at one sacro-iliac joint may prevent sufficient expansion of the pelvis.

### III. LOCALIZED AND SYMMETRICAL ANOMALIES IN DEVELOPMENT

These may be of several characters: (a) Imperfect development of both sacral alæ; (b) lack of union at the symphysis pubis; (c) lack of development of the vertebral bodies of the sacrum; (d) assimilation of the last lumbar vertebra with the sacrum, or of the first sacral vertebra with the lumbar column.

**The Transversely Contracted or Robert Pelvis.**—Imperfect development of the sacral alæ on both sides produces a pelvis which is markedly con-

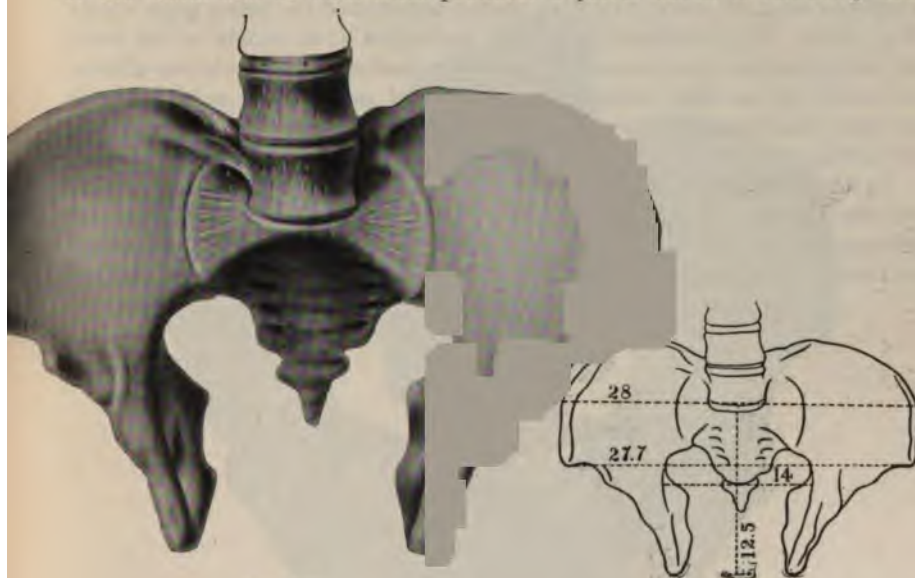


Fig. 592.

Fig. 593.

FIGS. 592, 593.—SPLIT PELVIS (Breus and Kolisko).

tracted transversely, and is sometimes described as the *double Naegele pelvis*. This variety is extremely rare, Tarnier stating that only 10 cases had been described up to 1898 (Fig. 590).

In the pelvis described by Robert, the alæ on both sides of the sacrum were lacking, and the innominate bones firmly synostosed with the rudimentary sacrum. The anterior surface of the latter was convex in both directions. Owing to the imperfect development of the sacrum, the pelvis was markedly contracted transversely, and only slightly antero-posteriorly, the transverse antero-posterior and diameters of the superior and inferior straits measuring 7 and 9.7, and 5.1 and 10.6 centimeters, respectively.

Just as in the Naegele pelvis, bony union between the sacrum and innominate bones is not an essential characteristic, and is occasionally lacking, sometimes on one, much more rarely on both sides. Where there is a difference in the development of the alæ on the two sides it can readily be understood how an asymmetrically transversely contracted pelvis may result.



The diagnosis is readily made, all of the transverse external measurements being markedly shortened while the external conjugate remains practically normal. Internal examination shows the conjugata vera to be only slightly changed, while it is hardly possible for the marked approach of the ischial spines and tuberosities to one another to escape recognition. In all cases thus far reported the transverse narrowing of the pelvis was so great as absolutely to preclude the possibility of the birth of a living child, and accordingly Cæsarean section is the only rational method of treatment.

**Split Pelvis.**—In rare instances union between the pubic bones at the symphysis does not occur, and the anterior portions of the pelvis gape widely (Fig. 592). This condition is usually associated with ectopia of the bladder and imperfect development of the lower portion of the anterior abdominal wall. It has been observed in adults, but naturally is more common in young children. We are indebted to Litzmann for the first accurate description of a pelvis of this character from an obstetrical point of view.

In the split pelvis, owing to descent of the promontory of the sacrum and the absence of union at the symphysis, there is marked transverse widening of the posterior portion of the pelvis, while its anterior portions are more or less parallel. External pelvimetry in such cases shows a marked



FIG. 594.—CONTRACTED PELVIS DUE TO ABSENCE OF BODIES OF SACRAL VERTEBRÆ (Litzmann).

flaring of the anterior superior spines of the ilium, and were the defective condition of the pubis not clearly evident a rachitic pelvis might be suspected.

The distance between the extremities of the pubic bones varies considerably, and occasionally is as great as 14 centimeters. This space is usually filled by a fibrinous band. Schickele, in 1901, reported a case of labor in

a pelvis of this character, and stated that 8 others are to be found in the literature. In only 2 of them was labor perfectly spontaneous, but in none was great difficulty experienced; consequently for practical purposes the pelvis may be considered as generally enlarged, the dystocia being due to abnormalities of mechanism resulting from the absence of a resistant anterior pelvic wall. Breus and Kolisko give an excellent description of several hitherto undescribed cases, and discuss fully the mechanical factors concerned in their production.

**Imperfect Development of the Vertebral Bodies of the Sacrum.**—Litzmann has described a remarkable pelvis, in which almost the entire sacrum



Fig. 595.



Fig. 596.

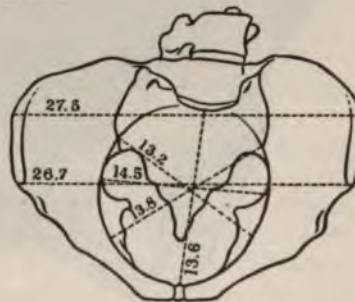


Fig. 597.

FIGS. 595-597.—HIGH ASSIMILATION PELVIS.

was lacking. This defect was associated with considerable transverse contraction, which increased as the inferior strait was approached, the transverse diameter of the superior strait measuring 10.5 centimeters, while the



distance between the ischial spines and ischial tuberosities was 6.5 and 8.5 centimeters respectively (Fig. 594).

**Assimilation Pelvis.**—Quite frequently the transverse processes of the



Fig. 598.

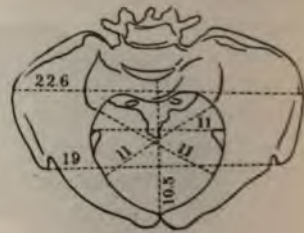


Fig. 599.

FIGS. 598, 599.—TRANSVERSELY CONTRACTED ASSIMILATION PELVIS (Breus and Kolisko)

last lumbar vertebra may be transformed into structures similar to the lateral masses of the sacral vertebrae. Hence the former assumes the functions of the first sacral vertebra, the sacrum being now composed of 6



FIG. 600.—LOW ASSIMILATION PELVIS (Breus and Kolisko).

instead of 5 pieces. In other instances the first sacral vertebra may take on the characteristics of a lumbar vertebra and be assimilated with the lumbar column, so that there are 6 lumbar and only 4 sacral vertebrae.

Occasionally the first coccygeal vertebra may become assimilated with the sacrum, but this has no effect upon the character of the pelvis.

Unless the entire vertebral column is available for study, it is frequently difficult to determine with which variety of assimilation one has to deal, as it is impossible to ascertain whether what corresponds to the first sacral vertebra is the twenty-fifth vertebra, as normal, or is the twenty-fourth or twenty-sixth vertebra, as the case may be. In the development of the pelvis the first portion of the sacrum to enter into the formation of the sacro-iliac joint is the twenty-sixth vertebra, which normally corresponds to the second sacral, the twenty-fifth vertebra not becoming involved until later. Accordingly, a sacrum with only four vertebræ may indicate the persistence of a fœtal type, while the presence of six vertebræ shows that the normal process of articulation has been exaggerated.



FIG. 601.—ASYMMETRICAL ASSIMILATION PELVIS (Breus and Kolisko)

Assimilation is the most common of all pelvic abnormalities, and is noted in at least every fifth or sixth pelvis. Indeed, it frequently happens that pelvis which have been demonstrated for years as typically normal present one or other type of this abnormality. Moreover, the condition may be associated with rhachitis or general imperfect development, so that one frequently has to deal with rhachitic or generally contracted assimilation pelvis (Fig. 552). More commonly, however, such an association is lacking, but the mere existence of assimilation may, nevertheless, give rise to marked changes in the shape of the pelvis.

When the last lumbar is assimilated with the first sacral vertebra—high assimilation—so that the sacrum consists of 6 pieces, important changes in the shape of the pelvis result, which depend in great part upon the



manner in which the sacrum and innominate bones articulate, as well as upon the width of the former. In some cases the condition gives rise to a pelvis which is very high in its posterior portion, and whose superior strait is almost round, the walls of its inferior portion converging, thus producing a funnel-shaped pelvis (see Fig. 595). In other cases the condition gives rise to a pelvis with a somewhat transversely contracted superior strait (see Fig. 598).

On the other hand, when the first sacral vertebra is assimilated with the lumbar column—low assimilation—a pelvis results which is very shallow in its posterior portion, but which offers no particular obstacle to labor (see Fig. 600).

Occasionally the assimilated vertebra may undergo only a partial change, one side of it retaining the characteristics of a lumbar or sacral vertebra, as the case may be, while the other side undergoes considerable modification. Under such circumstances asymmetrical pelves result, which are frequently obliquely contracted (see Fig. 601).

**Funnel Pelvis.**—While the most typical examples of funnel-shaped pelvis are associated with lumbo-sacral kyphosis, contractions of the pelvic outlet are also noted in spondylolisthetic, osteomalacic, obliquely contracted, and other rare types of abnormal pelves. These, however, occur so rarely that they are of scientific rather than practical importance.

On the other hand, moderate degrees of outlet contraction are frequently noted under other conditions. Thus, in every fourth or fifth generally contracted or justo-minor pelvis the measurements of the inferior strait may be diminished out of proportion to the rest of the pelvis, and occasionally to such an extent as to give rise to serious dystocia. In such cases, however, the diagnosis of general contraction should inevitably direct one's attention to the possible existence of the abnormality, so that it is not likely to pass unnoticed.

Unfortunately, more or less serious contraction of the outlet frequently occurs in pelves which appear to be perfectly normal, at least as far as the usual external and internal measurements are concerned. Such pelves I have designated as typical funnel, in contradistinction to the generally contracted variety to which reference has just been made, and they may pass unnoticed if appropriate measurements are not made, unless serious dystocia arises. In the latter event the physician may find himself in the embarrassing position of being obliged to resort to a serious operation in order to save the child, after having assured the patient that her pelvis was perfectly normal.

Whenever the transverse diameter of the outlet measures 8 cm. or less I designate the pelvis as funnel and, as stated in Chapter XXXIII, typical funnel pelves were noted in 6.1 per cent. of a series of 2,750 consecutive patients whom I examined up to April, 1911. Indeed, it is the most frequent abnormality observed in white women, making up 44 per cent. of the contracted pelves occurring in that race, and being almost as frequent as all of the other varieties combined. On the other hand, it constitutes only 15 per cent. of the abnormal pelves in black women. Notwithstanding this

progressive narrowing of the pubic arch, so that only a smaller and smaller segment of the head can pass beneath it, and in extreme cases only the portion of the outlet posterior to a line joining the ischial tuberosities is available for its passage. In such cases, it is evident that the possibility of delivery will depend not upon the actual length of the antero-posterior diameter, but rather upon the space available between the transverse diameter and the tip of the sacrum.

Klien has designated this distance as the posterior sagittal diameter of the outlet, and has devised a specially constructed pelvimeter for its men-

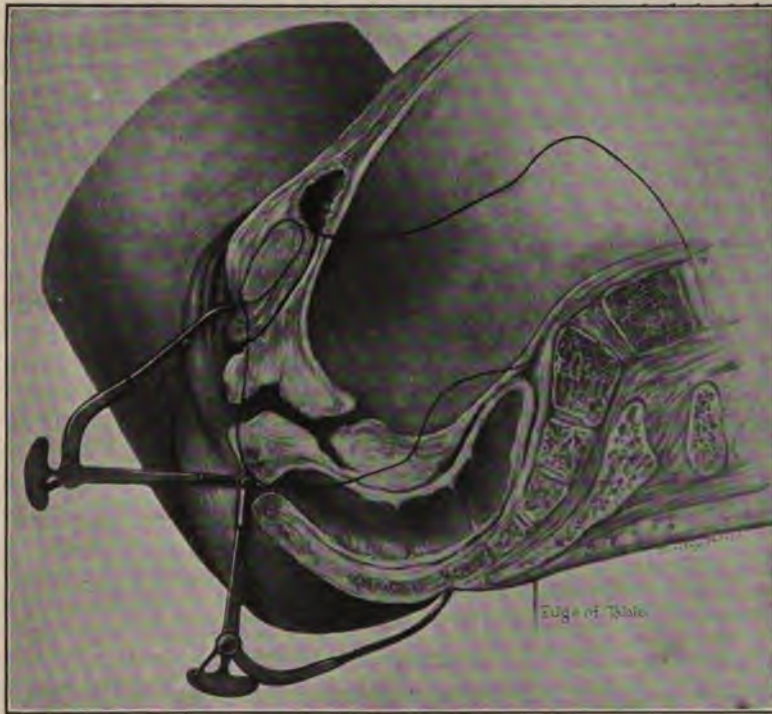


FIG. 606.—DIAGRAM SHOWING MENSURATION OF ANTERIOR AND POSTERIOR SAGITTAL DIAMETERS BY WILLIAMS'S MODIFICATION OF KLIEN'S PELVIMETER.  $\times \frac{1}{2}$ .

suration. Fig. 606 represents my modification of the instrument. In order to use it, the patient is placed upon a table with her buttocks projecting so far beyond its edge that the lower portion of the sacrum becomes readily accessible. The tubera ischii are then palpated and the location of the transverse diameter determined. The transverse bar of the pelvimeter is then placed in relation with it, and the distance to the tip of the sacrum is measured—this gives the length of the external posterior sagittal diameter. The pelvimeter is then rotated, and the distance to the lower margin of the symphysis is determined—antero-posterior sagittal diameter. This latter varies between 5 and 6 centimeters and is subject to comparatively little change; while the external posterior sagittal may vary greatly, and from it the length



of cases the distance between the tubera ischii is reduced to between 7 and 8 centimeters, but in several instances it was less, and in one instance measured only 5.5 centimeters (Figs. 602 and 603).

That contractions of this character may seriously affect the course of labor is shown by the fact that in 135 cases, which went to term, the following operations were necessary to effect delivery: namely, 17 forceps, 1 Cæsarean section, 3 pubiotomies, and 1 craniotomy upon the after-coming head. Moreover, even when the disproportion is not sufficiently great to give rise to marked dystocia, it may play an important part in the production of perineal tears. In such cases, with the increasing narrowing of the pubic arch, the occiput can not emerge directly beneath the symphysis pubis, and accordingly must stem itself further and further down upon the

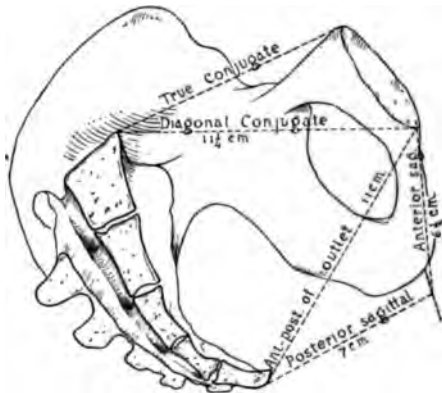


FIG. 604.—DIAGRAM SHOWING THE SIGNIFICANCE OF ANTERIOR AND POSTERIOR SAGITTAL DIAMETERS.  $\times \frac{1}{2}$ .

Cæsarean section in spite of a transverse diameter of 6.5 cm.

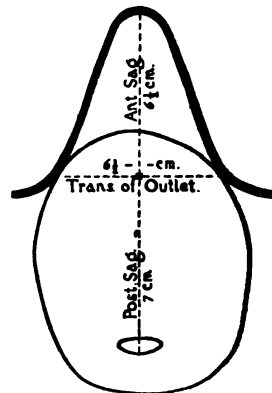


FIG. 605.—DIAGRAM OF PELVIC OUTLET OF SAME CASE, ILLUSTRATING NECESSITY FOR CÆSAREAN SECTION.  $\times \frac{1}{2}$ .

ischio-pubic rami, and in extreme cases must rotate around a line joining the ischial tuberosities. Consequently the perineum must become more and more distended, and thus be exposed to greater danger of extensive rupture.

In view of the frequency and practical significance of outlet contractions, palpation of the pubic arch, as described in Chapter XXXIII, should form an integral part of the preliminary examination of every pregnant woman. If any abnormality be detected the transverse and antero-posterior diameters of the outlet should be measured, and a shortening of the former to 8 centimeters or less should be regarded as a danger signal.

Unfortunately, as Klien pointed out in 1896, the length of either of these diameters does not afford a sufficient basis for the formulation of an intelligent prognosis. And it may happen that serious dystocia may sometimes arise with a transverse diameter of 7.5 centimeters, while on the other hand spontaneous labor may occur when it is reduced to 5.5 centimeters, as in one of my cases (Figs. 602-605).

The decrease in length of the transverse diameter is associated with a

progressive narrowing of the pubic arch, so that only a smaller and smaller segment of the head can pass beneath it, and in extreme cases only the portion of the outlet posterior to a line joining the ischial tuberosities is available for its passage. In such cases, it is evident that the possibility of delivery will depend not upon the actual length of the antero-posterior diameter, but rather upon the space available between the transverse diameter and the tip of the sacrum.

Klien has designated this distance as the posterior sagittal diameter of the outlet, and has devised a specially constructed pelvimeter for its men-

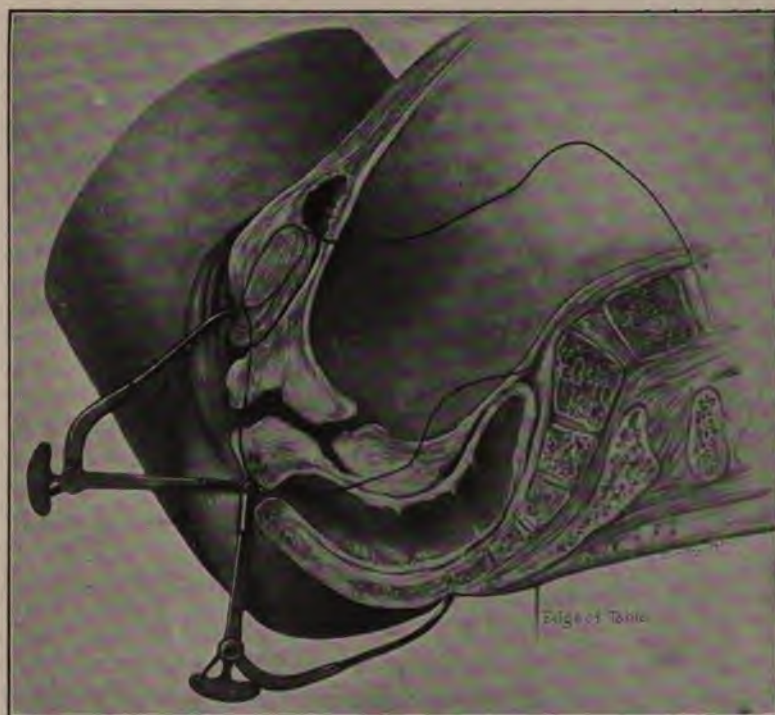


FIG. 606.—DIAGRAM SHOWING MENSURATION OF ANTERIOR AND POSTERIOR SAGITTAL DIAMETERS BY WILLIAMS'S MODIFICATION OF KLIEN'S PELVIMETER.  $\times \frac{1}{2}$ .

suration. Fig. 606 represents my modification of the instrument. In order to use it, the patient is placed upon a table with her buttocks projecting so far beyond its edge that the lower portion of the sacrum becomes readily accessible. The tubera ischii are then palpated and the location of the transverse diameter determined. The transverse bar of the pelvimeter is then placed in relation with it, and the distance to the tip of the sacrum is measured—this gives the length of the external posterior sagittal diameter. The pelvimeter is then rotated, and the distance to the lower margin of the symphysis is determined—antero-posterior diameter. This latter varies between 5 and 6 centimeters and is subject to comparatively little change; while the external posterior sagittal may vary greatly, and from it the length



of the posterior sagittal may be estimated by deducting 1 centimeter—the average thickness of the tip of the sacrum.

In order for spontaneous labor to occur it is apparent that this diameter must increase proportionally in length as the transverse diameter of the outlet is shortened, and my observations show that it is unlikely with measurements less than the following:

|                     |     |      |                    |     |     |
|---------------------|-----|------|--------------------|-----|-----|
| Transverse diameter | 8   | cm., | posterior sagittal | 7.5 | cm. |
| "                   | 7   | "    | "                  | 8   | "   |
| "                   | 6.5 | "    | "                  | 8.5 | "   |
| "                   | 6   | "    | "                  | 9   | "   |
| "                   | 5.5 | "    | "                  | 10  | "   |

It should, however, be understood that these are only approximate estimates and by no means accurately indicate the necessity for radical interference,

as spontaneous labor may occur when least expected. In multiparous women with a history of previous severe dystocia, they may afford an indication for Cæsarean section or pubiotomy; while in primiparous women, if spontaneous labor does not occur, they should lead us to substitute pubiotomy for brutal attempts at forceps delivery.



FIG. 607.—DIAGRAM ILLUSTRATING EFFECT OF PUBIOTOMY IN A PRONOUNCED FUNNEL PELVIS. Dotted lines show public arch before operation.  $\times \frac{1}{2}$ .

In young women pubiotomy is the operation of choice whenever the dystocia is serious, as it not only affects delivery at the time, but also offers a reasonable prospect of permanently overcoming the abnormality. In four of my patients the transverse diameter became permanently widened

following the operation. As the increase varied from 1 to 3 cm., the outlet became normal in two patients, while in the other two its transverse diameter increased from 6 to 7.5 and from 7 to 8 cm., respectively.

In moderate degrees of outlet contraction the effect of postural treatment should be tested before resorting to operative interference, as I have found that by placing the patient in an exaggerated Sims's position the innominate bones rotate upon the sacrum to such an extent that the length of the posterior sagittal undergoes an average increase of 0.75 cm., with extremes of 0 and 4 cm. In minor degrees of contraction, such an increase may be sufficient to do away with the necessity for the use of forceps.

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## CHAPTER XXXVII

### PELVIC ANOMALIES DUE TO DISEASE OF THE VERTEBRAL COLUMN

#### KYPHOTIC PELVIS

**History.**—Kyphosis or humpback, the result of spinal caries, plays an important part in the production of pelvic abnormalities, for when situated in the lower portion of the vertebral column it is usually associated with a characteristically funnel-shaped pelvis.

We are indebted to Rokitsansky for the first accurate work upon the

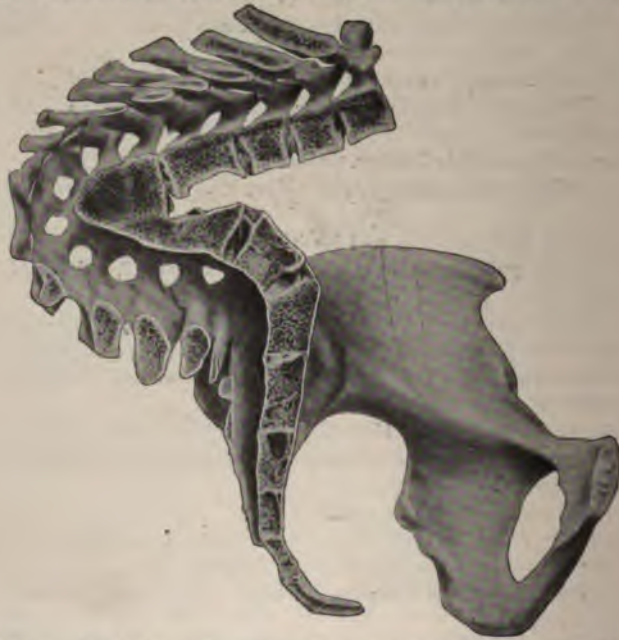


FIG. 608.—LONGITUDINAL SECTION THROUGH PELVIS AND SPINAL COLUMN IN DORSO-LUMBAR KYPHOSIS (Breus and Kolisko).

subject, although as early as 1759 Madame Boursier de Coudray reported a Cæsarean section performed upon a patient having a pelvis of this character.

The most important contribution to our knowledge concerning the kyphotic changes was made by Breisky (1865), who clearly set forth the mechanical factors by which the alteration in shape was brought about.

Later, Chantreuil, Champneys, Barbour, Treub, and particularly Breus and Kolisko added materially to our knowledge of the subject.

The effect exerted upon the pelvis by kyphosis differs according to its location. When the gibbus or hump is situated in the dorsal region, it is usually compensated for by marked lordosis beneath it, so that the pelvis itself is but little changed. On the other hand, when situated at the junction of the dorsal and lumbar portions of the vertebral column its effect upon the pelvis becomes manifest, and is still further accentuated when the kyphosis is lower down, being most marked when it is at the lumbo-sacral junction.

Klien analyzed 85 cases reported in the literature, and found that the kyphosis was dorso-lumbar in 24, lumbar in 17, and lumbo-sacral in 37

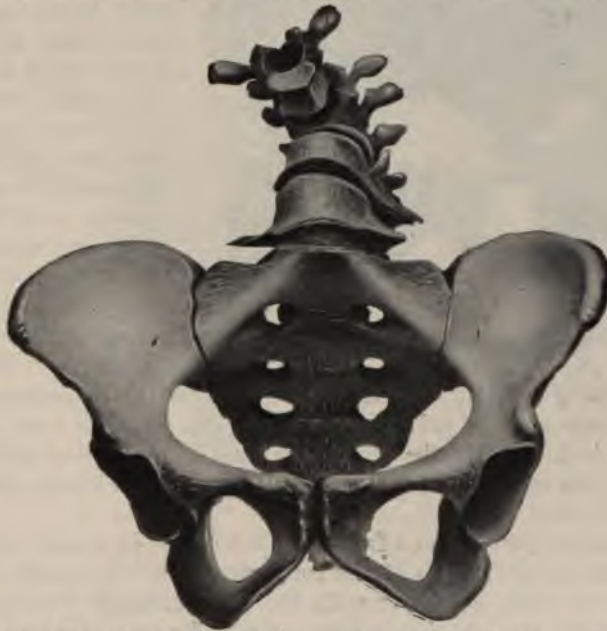


FIG. 609.—KYPHOTIC PELVIS, SHOWING ELONGATION OF CONJUGATA VERA.

cases, while in 7 other cases the vertebral column so overhung the superior strait as to produce a "*pelvis obtecta*" (Fig. 610).

**Characteristics.**—The characteristic feature of the kyphotic pelvis is a retropulsion and rotation of the sacrum, by which the promontory becomes displaced backward and the tip forward. At the same time the entire bone becomes elongated vertically, and narrowed from side to side. These changes are associated with a rotation of each innominate bone about an axis, which extends through the symphysis pubis and the sacro-iliac articulation, so that the iliac fossæ become flared outward while the lower portions of the ischial bones are turned in toward the middle line.

When the kyphosis is in the dorso-lumbar region, marked lordosis below it indicates an attempt at compensation, but as this is imperfect the body weight is transmitted to the sacrum in such a manner that the latter be-



comes markedly retroposed and lengthened, its promontory being farther backward and at a higher level than usual. At the same time its anterior surface loses its normal vertical concavity and becomes straight or even convex; while its lateral concavity is obliterated by the projection of the vertebral bodies beyond their alæ. The bodies themselves are considerably narrower than usual, and the alæ of the first sacral vertebra appear to be drawn out and to extend obliquely upward to the promontory.

Owing to its backward displacement the posterior surface of the sacrum approaches the superior posterior spines, thereby relaxing the ilio-sacral ligaments. At the same time the posterior



FIG. 610.—PELVIS OBTECTA (Fehling).

extremities of the innominate bones are pushed apart, and as a consequence their upper portions rotate outward and the lower portions inward, so that the crests are flared out and occupy a lower level than usual, while the ischial spines and tuberosities approach the middle line. This movement of rotation is still further accentuated

by the increased tension exerted by the ilio-femoral ligaments resulting from a diminution of the pelvic inclination. The acetabula also are shifted slightly and look more to the front than usual. Coincident with the displacement of the sacrum, the ilio-pectineal line becomes longer, particularly in its iliac portion.

These changes give rise to a funnel-shaped pelvis, in which, as the result of the increase in the length of the conjugata vera, the superior strait becomes round or oval in shape, with the long diameter running antero-posteriorly, while the transverse diameter remains unchanged or may even be somewhat shorter than usual. There is also a gradual diminution of all the antero-posterior diameters of the pelvis below the superior strait, but the most characteristic change is the shortening of the distance between the ischial spines, and to a somewhat less extent of that between the ischial tuberosities. The pelvic inclination is usually decreased, though in some cases it is only slightly altered.

In 18 kyphotic pelvises described by Breus and Kolisko the conjugata vera varied from 10.7 to 16.5 centimeters in length, the distance between the spines from 5.2 to 8.2 centimeters, and that between the ischial tuberosities from 6 to 12.1 centimeters. At the same time it should be remembered that in not a few cases the entire cavity is smaller than usual, Klien having pointed out that 30 per cent. of all the kyphotic pelvises described were also generally contracted, so that a conjugata vera which at first glance appears normal may in reality be relatively increased in length.

When the kyphosis is situated at the junction between the last lumbar and the first sacral vertebræ, the pelvic changes are generally more marked than those just described, as the promontory of the sacrum is usually carious and takes part in the formation of the gibbus. In such cases there

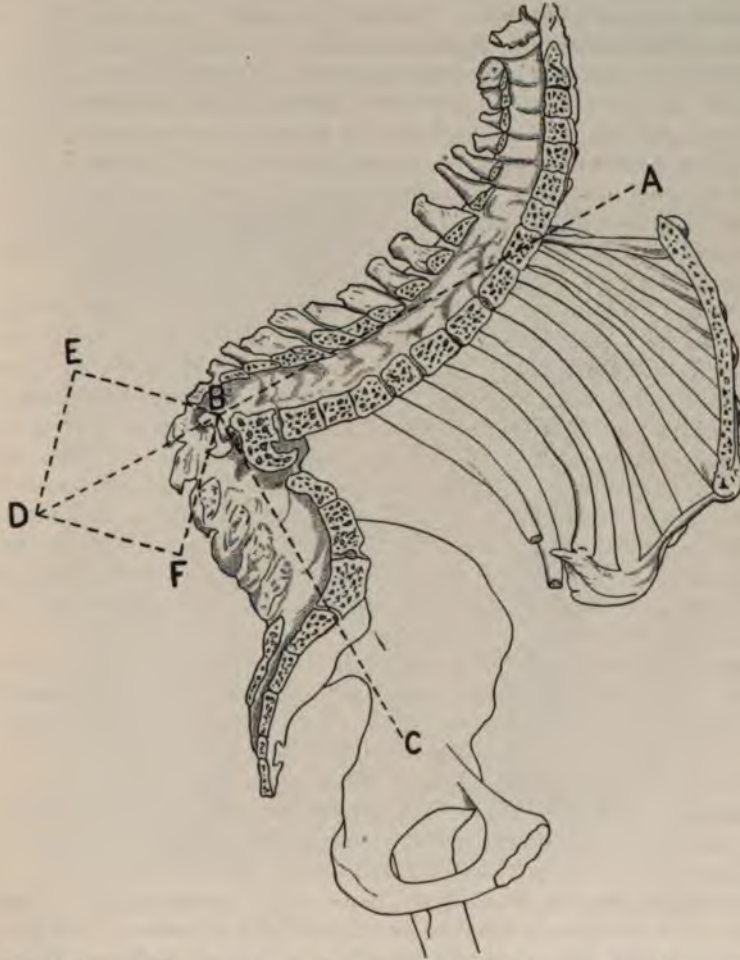


FIG. 611.—DIAGRAM SHOWING FORCES CONCERNED IN THE PRODUCTION OF KYPHOTIC PELVIS (Tarnier).

can be no attempt at compensation, as the body weight is transmitted directly to the anterior surface of the sacrum, so that its upper part is pushed far backward. It is not lengthened, and its alæ are usually very small. In such cases the transverse contraction becomes still more marked, so that the distance between the ischial spines may be reduced to 3 or 4 centimeters, as in the cases described by Schroeder and Doktor. The pelvic inclination is always diminished, and in some cases is entirely obliterated.

When the kyphosis is very marked, the lumbar vertebræ may so over-



comes markedly retroposed and lengthened, its promontory being farther backward and at a higher level than usual. At the same time its anterior surface loses its normal vertical concavity and becomes straight or even convex; while its lateral concavity is obliterated by the projection of the vertebral bodies beyond their alæ. The bodies themselves are considerably narrower than usual, and the alæ of the first sacral vertebra appear to be drawn out and to extend obliquely upward to the promontory.

Owing to its backward displacement the posterior surface of the sacrum approaches the superior posterior spines, thereby relaxing the ilio-sacral ligaments. At the



FIG. 610.—PELVIS OBTECTA (Fehling).

same time the posterior extremities of the innominate bones are pushed apart, and as a consequence their upper portions rotate outward and the lower portions inward, so that the crests are flared out and occupy a lower level than usual, while the ischial spines and tuberosities approach the middle line. This movement of rotation is still further accentuated

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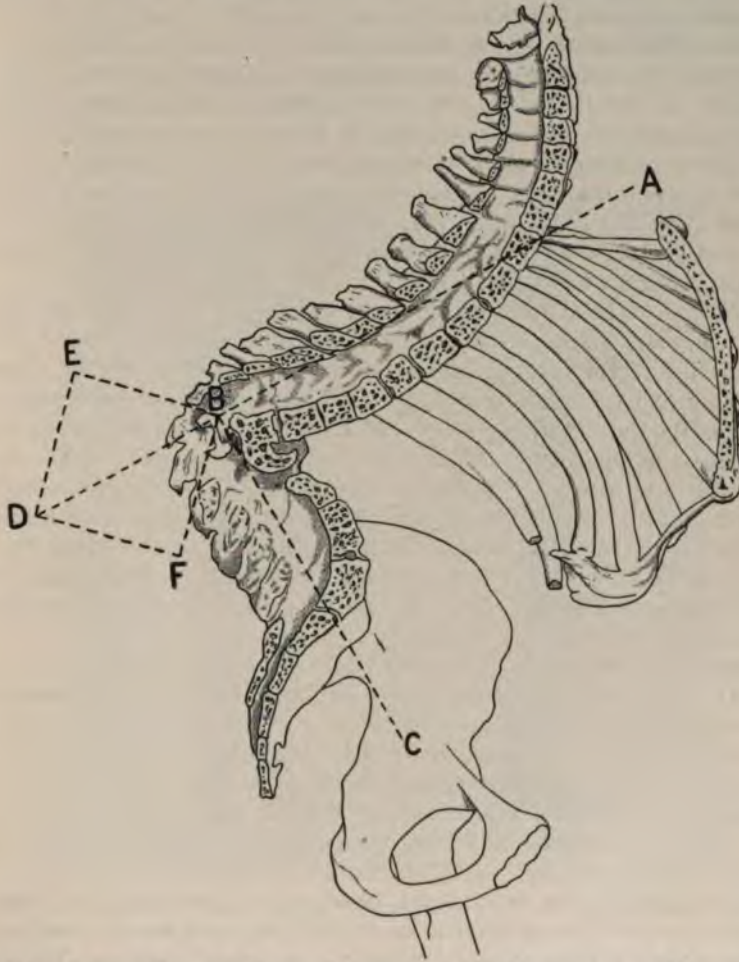


FIG. 611.—DIAGRAM SHOWING FORCES CONCERNED IN THE PRODUCTION OF KYPHOTIC PELVIS (Tarnier).

can be no attempt at compensation, as the body weight is transmitted directly to the anterior surface of the sacrum, so that its upper part is pushed far backward. It is not lengthened, and its alæ are usually very small. In such cases the transverse contraction becomes still more marked, so that the distance between the ischial spines may be reduced to 3 or 4 centimeters, as in the cases described by Schroeder and Doktor. The pelvic inclination is always diminished, and in some cases is entirely obliterated.

When the kyphosis is very marked, the lumbar vertebræ may so over-



to the approach of the tubera ischii, has become more angular than usual, so that the head is prevented from coming in contact with the lower margin of the symphysis pubis and must descend lower than usual in order to be born. This fact readily explains the deep perineal tears so frequently observed.

Generally speaking, it may be said that when the distance between the tubera ischii is less than 8 centimeters labor becomes difficult or impossible, according to the degree of contraction of the transverse diameter of the outlet. In such cases the dystocia is more pronounced than in typical funnel pelves presenting identical measurements, for the reason that the anterior displacement of the tip of the sacrum is inevitably associated with shortening of the posterior sagittal diameter. (See p. 785.) Owing to the narrowing of the pubic arch, occipito-anterior are less favorable than occipito-posterior presentations, as in the former the wide biparietal diameter has to accommodate itself to the pubic arch, whereas in the latter its place is taken by the brow. According to Klien, face presentations are still more favorable for the same reason.

**Prognosis.**—If the contraction is at all marked, the prognosis is bad unless Cæsarean section is resorted to. Klien has analyzed the histories of 175 labors occurring in 95 women, and found that 40 per cent. of the children died. The maternal mortality varied according to the degree of contraction; when the disproportion between the biparietal diameter of the child's head and the distance between the spines was slight, it was 6.2 per cent., as compared with 17 per cent. in marked cases.

Neugebauer has likewise analyzed the histories of 199 labors occurring in 118 women, and found that only 44 ended spontaneously. The maternal mortality was 24.3 per cent., and 49 per cent. of the children died.

**Treatment.**—When the distances between the spines and tuberosities of the ischium do not fall below 8 centimeters, spontaneous labor, or at least a probable delivery with forceps, can be looked for, provided the posterior sagittal diameter is not too shortened; but when the measurements are below this limit operative interference becomes necessary. Cæsarean section is usually the operation of choice, unless the child is very small. Pubiotomy, however, may be considered if the deformity is not too pronounced, as it will give a sufficient increase in the size of the pelvic outlet to permit the passage of the head, provided the distance between the spines or tubera does not fall below 6 centimeters. If the child is already dead, craniotomy is the operation of election.

### KYPHO-RHACHITIC PELVIS

Kyphosis is nearly always of carious origin, but when due to rhachitis it is usually associated with a greater or lesser degree of scoliosis. In the rare cases of pure rhachitic kyphosis, however, the pelvic changes are slight, as the effect of the kyphosis is counterbalanced to a great extent by that of the rhachitis, the former leading to an elongation and the latter to a shortening of the conjugata vera, while tending respectively to narrow and widen the inferior strait. Thus it may happen that a woman presenting a

markedly deformed vertebral column of this character may still have a practically normal pelvis. The two processes, however, do not always counteract one another, and, as a rule, when the kyphosis is high up the pelvic changes are predominantly rhachitic.

### SCOLIOTIC PELVIS

Pronounced scoliosis, or lateral curvature of the spine, is usually of rhachitic origin; but, on the other hand, minor degrees of the deformity are often observed which have no connection with rickets. When the scoliosis involves the upper portion of the vertebral column, it is usually compensated

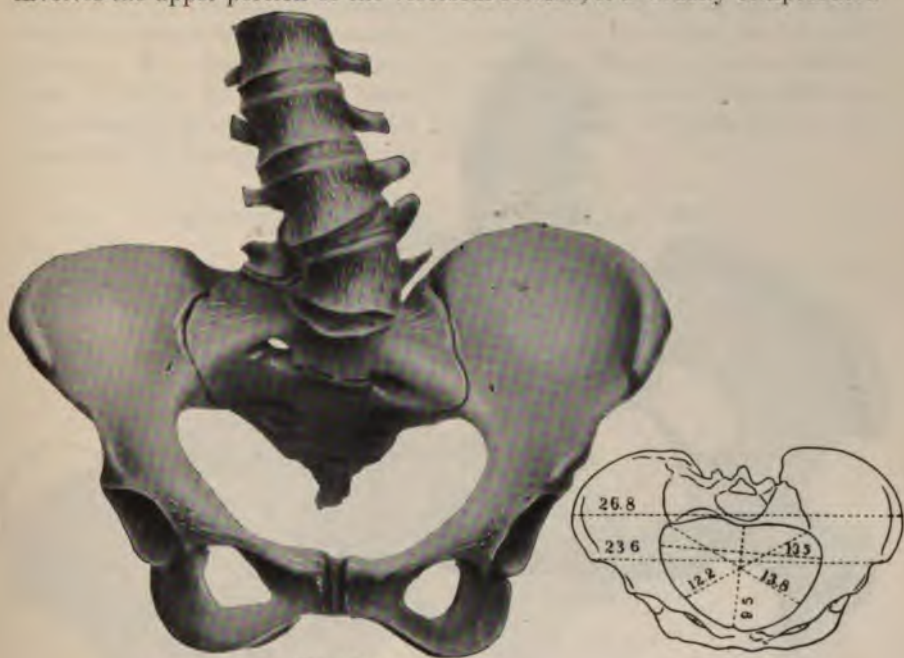


Fig. 613.

Fig. 614.

FIGS. 613, 614.—OBLIQUELY CONTRACTED NON-RHACHITIC SCOLIOTIC PELVIS (Breus and Kolisko).

for by a corresponding curvature in the opposite direction lower down, thus giving rise to a double or S-shaped curve. In such cases the body weight is transmitted to the sacrum in the usual manner. But when the scoliosis is lower down and involves the lumbar region, the sacrum takes part in the compensatory process and accordingly assumes an abnormal position which leads to slight asymmetry of the pelvis.

Breus and Kolisko have devoted particular attention to the pelvic anomalies resulting from non-rhachitic scoliosis, but the changes in shape are usually so slight as to have little or no effect upon the course of labor.

When due to rhachitis, the scoliosis may be very pronounced, and give rise to marked pelvic deformity, in which the characteristic changes



due to the anomaly of the vertebral column are superadded to those resulting from rhachitis. In such cases the scoliotic convexity is usually directed to the right side, as was noted in 7 out of the 9 cases described by Leopold.

Under such circumstances the sacrum takes part in the compensatory scoliosis, one side being compressed and the other elongated, so that its long axis becomes directed obliquely toward one side. At the same time it undergoes a partial rotation about its vertical axis, the spinous processes being directed toward the compressed side, a result which indicates the abnormal direction along which the body weight is transmitted to the iliac bone, and thence to the femur. Owing to the abnormal pressure exerted upon one side, the pelvis becomes obliquely contracted, usually



Fig. 615.



Fig. 616.

FIGS. 615, 616.—SCOLIO-RHACHITIC PELVIS (Tarnier).

upon the side corresponding to the lumbar convexity; but, owing to the coexistence of rhachitic changes, the contraction is in great part limited to the superior strait.

Owing to the pressure exerted upon the compressed side of the sacrum, ankylosis at the sacro-iliac articulation often occurs. At the same time the innominate bone on the affected side is displaced upward, inward, and backward, while its acetabulum looks more forward than usual. The symphysis pubis is brought somewhat nearer to the opposite side, and owing to the rhachitic changes the pubic arch is widened, while the tubera ischii are directed outward instead of inward as in the Naegele pelvis. In pronounced cases the superior strait assumes an obliquely ovate appearance, and occasionally the acetabulum on the affected side may come almost in contact with the promontory.

The location of the contraction can be determined by external examination, as it always lies upon the side toward which the convexity of the scoliosis is directed. The contracted side is valueless from an obstetrical standpoint, and for practical purposes the superior strait becomes generally narrowed. If, however, the head manages to pass through it, no further difficulty is experienced in its downward course, owing to the rhachitic widening of the lower portion of the pelvis.

### KYPHO-SCOLIOTIC PELVIS

The distortion of the pelvis will vary according as the kyphosis or the scoliosis is the predominant factor in the deformity of the spinal column. When the former is more pronounced the pelvis will partake of the kyphotic character, and *vice versa*. When the two deformities are approximately equal, however, the kyphotic changes in the pelvis predominate, although the influence of the scoliosis tends to counteract, to a certain extent, the transverse narrowing of the inferior strait.

### KYPHO-SCOLIO-RHACHITIC PELVIS

This variety of pelvic deformity has been studied more particularly by Leopold, and Barbour. As has already been pointed out, a kyphosis due to



Fig. 617.

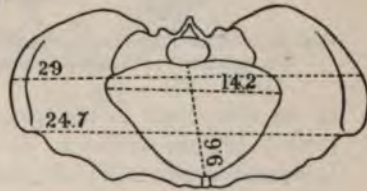


Fig. 618.

FIGS. 617, 618.—KYPHO-SCOLIOTIC-RHACHITIC PELVIS (Leopold).

rhachitis is nearly always complicated by a scoliosis, and the latter usually predominates in the production of the pelvic deformity, for the reason that the kyphosis and the rhachitis tend mutually to counteract one another in their effect upon the pelvis. Accordingly, the resulting pelvis does not



differ materially from that observed in scolio-rhachitis, except that the tendency to antero-posterior flattening is partially counteracted by the action of the kyphotic vertebral column. Nevertheless, owing to the presence of the scoliosis, the oblique deformity of the superior strait is usually quite marked. Generally speaking, however, this class of pelvis is more favorable from an obstetrical standpoint than that due to scolio-rhachitis alone.

### SPONDYLOLISTHETIC PELVIS

The term spondylolisthesis (from *σπόνδυλος*, vertebra, and *σλίσθησις*, slipping or sliding) was introduced by Kilian in 1853, in describing a pelvis in which the last lumbar vertebra had become displaced downward over the anterior surface of the sacrum.

**Characteristics.**—The degree of displacement may vary greatly. When the deformity is slight the anterior inferior margin of the last lumbar

vertebra merely projects a short distance beyond the anterior margin of the promontory of the sacrum; while in pronounced cases the entire body of the vertebra is displaced downward and forward into the pelvic cavity, so that its inferior surface comes in contact with, and more or less completely covers, the body of the first, and occasionally that of the second sacral vertebra. As a consequence, a greater or lesser portion of the lumbar column comes to occupy the upper portion of the pelvic cavity, the superior strait becoming markedly obstructed and assuming a reniform shape.

The lower lumbar vertebræ may overhang the pelvic inlet to such an extent that the obstetrical or pseudo-conjugate will be represented by a line drawn from the upper margin



FIG. 619.—VERTICAL SECTION THROUGH SPONDYLOLISTHETIC PELVIS (Kilian).

of the symphysis to the lower margin of the fourth, third, or even of the second lumbar vertebra, as the case may be. In the specimen which I described in 1899, it extended to the lower margin of the third lumbar vertebra and measured 6.5 centimeters, as compared with 7.6 centimeters to the lower margin of the fourth lumbar. The displacement of the last lumbar vertebra is due not to luxation, but to the lengthening and bending of its interarticular portions. Its inferior articular processes still retain their normal relation to the superior articular processes of the first sacral vertebra, whereas its body and its superior articular processes, together with the rest of the vertebral column, become

displaced forward and eventually downward. As a result of the new position assumed by the body of the last lumbar vertebra, the superior and anterior surfaces of the promontory become more or less worn away by friction, the defect being frequently followed by ankylosis which definitely checks further displacement. In advanced cases the inferior articular processes of the last lumbar and the superior articular processes of the first sacral vertebra are usually firmly synostosed together, as are also the inferior articular processes of the fourth and the superior articular processes of the fifth lumbar vertebra.

Owing to the collapse of the vertebral column into the pelvic cavity

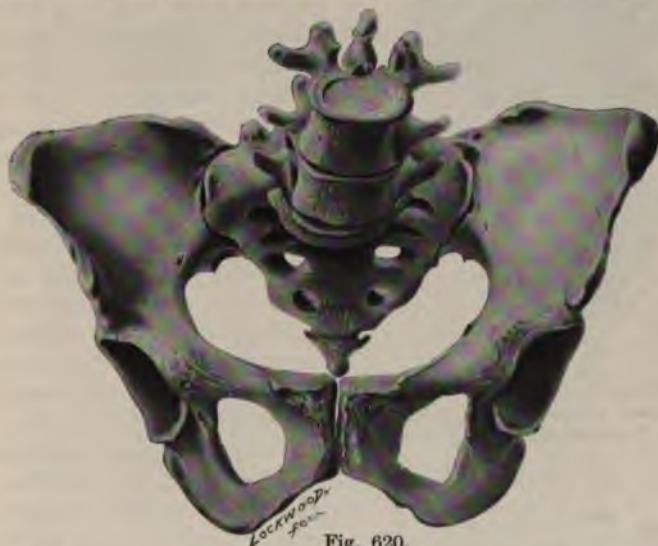


Fig. 620.

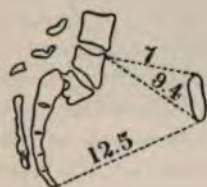


Fig. 621.



Fig. 622.

FIGS. 620-622.—WILLIAMS'S SPONDYLOLISTHETIC PELVIS.

the center of gravity falls in front of instead of just behind the acetabula, and consequently the pelvis must be tilted backward in order that the individual may retain an upright position. In other words, the pelvic inclination must be diminished, and when the deformity is marked the plane of the superior strait becomes parallel to, or even forms an obtuse angle with, the horizon. This is rendered possible by changes in the ilio-femoral ligaments, which are manifested on the one hand by a marked roughening of the portions of the pelvis to which they are attached, and on the other



## PATHOLOGY OF THE DISEASE OF VERTEBRAL COLUMN

...in the gait of the patient. In my own case the ...; but, had it remained normal, the vertebral column would have formed a right angle with the legs, necessitating the patient's going upon all-fours, whereas, as a matter of fact, she was able to walk erect.

As the inferior surface of the last lumbar vertebra is in contact with the anterior instead of the superior surface of the first sacral vertebra, the action of the body weight tends to force the promontory of the sacrum backward, thereby causing it to rotate about its transverse axis, while its tip approaches the lower margin of the symphysis pubis. This rotation, together with the increased traction exerted by the ilio-femoral ligaments, causes each innominate bone to rotate about an axis extending from the symphysis to the sacro-iliac joint, and tends to give the pelvis a funnel shape, just as in kyphosis, the inferior strait becoming considerably contracted transversely.

VESTIBULAR  
THREE  
SACRUM.



FIG. 81

of the second lumbar vertebra. I determined the lengthening of the articular processes of the lumbar vertebra. B, trans-articular process; F, transverse process; I, interarticular process.

**Ætiology.**—Kilian considered that the displacement of the last lumbar vertebra was rendered possible by inflammatory softening of the intervertebral disk. Later, various hypotheses were advanced as to its mode of production. Robert, Lambl, and Königstein showed that the displacement could not take place so long as the inferior articular processes of the last lumbar were normal and in contact with the superior articular processes of the first sacral vertebra, unless the entire vertebra became lengthened.

Neugebauer devoted thirteen years (1882-95) to the study of this subject, and during that period published 15 journal articles and 3 monographs upon it, covering nearly 900 pages, not to mention the discussions and demonstrations in which he took part. He showed conclusively that in the vast majority of cases the deformity was rendered possi-

ble by a lengthening and thinning out of the interarticular portions of the last lumbar vertebra, by which its superior and inferior articular processes become separated by a long, thin lamina of bone instead of being almost in the same vertical line (Fig. 624).

This condition he attributed to imperfect development of the interarticular portion (spondylolysis) or to its fracture, with subsequent stretching of the callus. He considered that the former was the more frequent cause, as he was able to demonstrate it in many vertebræ which presented no signs of spondylolisthesis. When the displacement is marked the interarticular portion is not only lengthened and thinned out, but also becomes



FIG. 625.—FRONT AND BACK VIEWS OF WOMAN WITH SPONDYLOLISTHESIS (Ahlfeld).

bent over the promontory of the sacrum, thus forming a *dolicho-kyrtolaty-spondylus*.

In opposition to Neugebauer's statement that the deformity always results from changes in the interarticular portion, Chiari definitely showed that it can occasionally follow fracture of the articular processes without the characteristic changes in the vertebra. At the same time, he holds that spondylolysis is the usual cause.

Arbuthnot Lane stated that the disease is more common than is generally supposed, as he observed several examples of it in coal-heavers. He considers that in such cases, at least, the changes in the interarticular portion are due not to abnormalities in development but to excessive pressure, which results from carrying heavy burdens. Complete literature upon



the subject will be found in my own article, and in those of Breus and Kolisko, and Chiari.

**Frequency.**—Neugebauer, in 1893, was able to collect 115 cases of spondylolisthesis, most of which were clinical observations. In 1899 I collected 123 cases, which Chiari, in 1911, increased to 147, including 12 cases occurring in males—8.1 per cent. According to Breus and Kolisko only 20 indisputable anatomical specimens of this condition were in existence in 1900, including 2, which they described for the first time.

**Effect upon Labor.**—When the condition is but slightly marked, its effect upon labor is similar to that of a flat pelvis, as the greatest contraction is in the conjugata vera, although it should be remembered that it is likewise associated with considerable contraction of the inferior strait.

When the deformity is pronounced and the lower lumbar vertebræ overhang the superior strait, the degree of contraction, from an obstetrical point of view, is to be reckoned not by the distance between the symphysis pubis and the anterior portion of the last lumbar vertebra, but by the length of the pseudo-conjugate, whose posterior extremity may be at the fourth, third, or even second lumbar vertebra, and in many cases is so short as absolutely to preclude the possibility of the head entering the pelvis.

**Diagnosis.**—In typical cases mere inspection of the patient should lead one to suspect the existence of this deformity, inasmuch as there is always marked lumbar lordosis and the entire trunk seems to have caved in, so that the ribs may come almost in contact with the iliac crests. When viewed from the front the abdominal walls appear unusually redundant. Such patients have a peculiar duck-like walk or waddling gait, to which Neugebauer first directed attention. Since the posterior portion of the last lumbar vertebra retains its normal position while the rest of the vertebral column sinks forward, its spine will sometimes form a marked prominence just above the sacrum. The condition, however, should not be mistaken for a deep-seated kyphosis.

On internal examination the diagnosis, as a rule, is readily made, as, on attempting to measure the diagonal conjugata, the body of the last lumbar vertebra will be found lying in front of the anterior and upper portion of



FIG. 626.—SIDE VIEW OF AUTHOR'S SPONDYLOLISTHETIC PATIENT, SHOWING PROJECTING SPINE OF LAST LUMBAR VERTEBRA.

the sacrum. At the same time the ilio-pectineal line ends abruptly at the margins of the overhanging vertebral body, instead of continuing uninterruptedly to the promontory of the sacrum.

Owing to the marked lordosis, which frequently accompanies the condition, the bodies of the lower lumbar vertebræ can readily be palpated and counted, and the bifurcation of the aorta, or at least the common iliac arteries, are frequently readily accessible to the examining finger.

Occasionally pronounced rhachitic changes in the sacrum may simulate spondylolisthesis, but a correct diagnosis can usually be arrived at. If such patients be anæsthetized, careful palpation will show that the ilio-pectineal lines terminate at the promontory of the sacrum instead of at the sides of the prolapsed body of the last lumbar vertebra.

A somewhat similar condition is presented in marked cases of lumbosacral kyphosis, particularly in the pelvis obtecta. Under such circumstances the promontory of the sacrum is destroyed, but a correct diagnosis can usually be made by carefully palpating the anterior surface of the sacrum and tracing the alæ to the body of the first vertebra, which, of course, is impossible in spondylolisthesis.

**Prognosis.**—Generally speaking, spontaneous labor can occur only when the deformity is minimal, and, accordingly, in pronounced cases the outlook is uniformly bad for both mother and child unless radical operative measures be undertaken. Other things being equal, a spondylolisthetic pelvis offers a worse prognosis than a rhachitic one with the same antero-posterior measurements, for the reason that in the former the inferior strait is contracted, while in the latter it is usually enlarged.

In considering the probable outcome of labor, one should measure the pseudo-conjugate with particular care, inasmuch as it, rather than the antero-posterior diameter of the superior strait, usually offers the greatest obstacle to labor. The fact that a patient with spondylolisthesis has had one or more spontaneous labors does not necessarily imply that the labor in question will be uneventful, for the reason that the degree of deformity frequently increases with age, as was clearly demonstrated in my own case.

**Treatment.**—With a pseudo-conjugate of 8 centimeters or more, the possibility of spontaneous labor should be borne in mind; but when it falls below that limit Cæsarean section should be done at the onset of labor. In slight degrees of contraction, in which spontaneous delivery has failed to occur, the propriety of pubiotomy may be considered; but in Morisani's case, as well as in my own, symphyseotomy proved fatal. In my case the operation was clearly contraindicated, but was performed in my absence by an assistant, after the patient had refused to submit to Cæsarean section.

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## CHAPTER XXXVIII

### PELVIC ANOMALIES RESULTING FROM THE ABNORMAL DIRECTION OF THE FORCE EXERTED BY THE FEMORA—ATYPICAL DEFORMITIES

Normally, in the case of an individual standing erect, the upward and inward force exerted by the femora is of equal intensity on either side, and is transmitted to the pelvis through the acetabula. In walking or running the entire body weight is transmitted alternately first to one and then to the other leg. On the other hand, in a person suffering from disease affecting one leg, the sound one has to bear more than its share of the body weight, and consequently the upward and inward force exerted by the femur is, as a rule, greater upon that side of the pelvis. To these mechanical factors are due the changes in shape which accompany certain forms of lameness, provided that the lesion, which gives rise to the latter, appears at an early period of life while the pelvic bones are still in a formative state.

The defect may be either unilateral or bilateral; in the former case it is usually due to coxitis, luxation of the femur, infantile paralysis, or

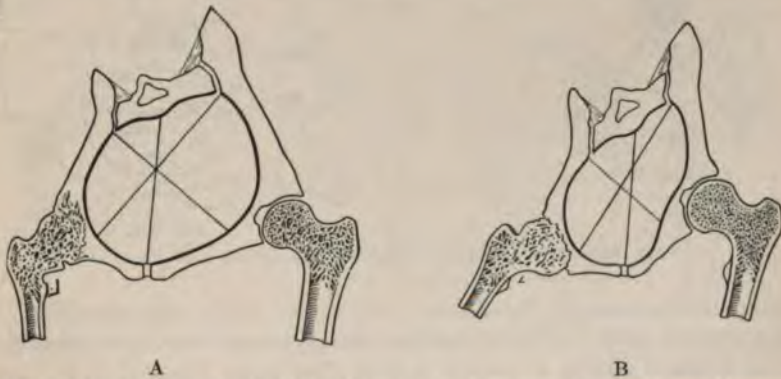


FIG 627.—DIAGRAM SHOWING COXALGIC PELVIS, A, BEFORE AND, B, AFTER THE INDIVIDUAL HAS WALKED.

shortening of one leg from various causes, while the most common causes of the latter are luxation of both femora and double club-foot. These conditions have been studied in detail by Prouvost, in whose article, as well as in the chapters of Tarnier and Budin, and of Breus and Kolisko upon the subject, full literature is to be found.



### PELVIC DEFORMITIES DUE TO UNILATERAL LAMENESS

**Ætiology.**—*Coxitis* occurring in early life nearly always gives rise to an obliquely contracted pelvis. If the disease makes its appearance before the patient learns to walk, or if the child is obliged to keep to its bed for a prolonged period, definite changes occur in the pelvis as a direct result of the disease. These are in great part atrophic, and are manifested by im-



Fig. 628.



Fig. 629.



Fig. 630.

FIGS. 628-630.—COXALGIC PELVIS WITH ANKYLOSED FEMUR.

perfect development of the diseased side of the pelvis, the innominate bone being smaller than its fellow and the ilio-pectineal line represented by the arc of a circle having a smaller radius than upon the well side. At the same time, the sacral alæ are less developed upon the affected side, and the entire bone is somewhat rotated about its vertical axis, so that its anterior surface looks toward the well side (Fig. 627, A and B).

When the individual begins to stand, owing to the actual shortening of the diseased leg or to fear of placing it firmly upon the ground, the body weight is transmitted in great part to the well leg. As a result the pelvis becomes obliquely tilted, being higher on the well side, and a compensatory scoliosis appears. At the same time the upward and inward force exerted

by the femur tends to push the well side of the pelvis upward, inward, and backward, whereby the ilio-pectineal line is markedly flattened and the asymmetry of the sacrum still further increased, thus giving rise to an obliquely contracted pelvis. The contraction is not limited to the superior strait, but involves the lower portion of the pelvis as well, the spine and tuberosity of the ischium being displaced toward the middle line.

Not uncommonly these changes are accompanied by irritative processes at the sacro-iliac articulations, which eventually lead to ankylosis. As a



Fig. 631.



Fig. 632.

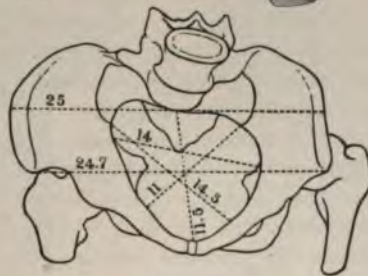


Fig. 633.

FIGS. 631-633.—OBLIQUELY CONTRACTED PELVIS, DUE TO UNILATERAL LUXATION OF FEMUR

general rule, the oblique contraction is to be found on the well side of the pelvis, but, according to Tarnier, the reverse is the case when the affected leg is ankylosed in a position of adduction and internal rotation (Fig. 628).

Usually as the result of gonorrhœal coxitis, the base of one or both acetabula may yield to the pressure exerted by the head of the femur, and project into the pelvic cavity, thus leading to a uni- or bi-lateral transverse contraction, which when pronounced may give rise to serious dystocia. Eppinger, who studied the condition exhaustively in 1903, designated such



pelvis as coxarthrolithetic, and attributed their production to deficient and delayed ossification of the base of the acetabulum. Breus and Kolisko, on the other hand, have shown that the deformity was known to A. W. Otto in 1824, and have demonstrated that it results from a coxitis, which is usually gonorrhœal in origin. The condition is rare, only 11 cases being recorded up to 1912.

Oblique contraction of the pelvis may also develop when *unilateral luxation* of the femur occurs in early life, although they are usually less pronounced than those following coxitis. Under such circumstances the head of the bone is displaced backward and upward upon the outer surface of the ilium, where a new joint surface may occasionally be formed. The affected leg becomes considerably shortened, and accordingly an undue share of the body weight is transmitted through the well leg, which forces the corresponding side of the pelvis upward, inward, and backward, and leads to an oblique contraction, just as in coxalgia.

In *unilateral infantile paralysis*, and in those cases in which disease at the knee- or ankle-joint or amputation has caused shortening of one leg, unless the patient has had the benefit of proper orthopædic treatment, similar changes occur in the pelvis, though it rarely assumes the extreme degree of obliquity which characterizes the coxitic variety.

**Diagnosis.**—A limping gait at once suggests an obliquely contracted pelvis, and when, upon questioning the patient, it is found that the condition has been present since early childhood, the existence of pelvic deformity upon the side corresponding to the sound leg becomes highly probable.

More accurate information can be obtained by careful examination and noticing the relative position of the iliac crests and the presence or absence of compensatory scoliosis, and finally an absolute diagnosis can be arrived at by the employment of the measurements suggested by Naegele for the detection of the obliquely contracted pelvis due to imperfect development of the sacral alæ. An accurate conception concerning the degree of contraction, however, can be obtained only by careful exploration of the interior of the pelvis, preferably with the patient under the influence of an anæsthetic, although in many coxalgic patients this may be extremely difficult on account of the ankylosis of one leg.

**Effect upon Labor.**—The effect of this class of pelvis upon labor varies with the extent and position of the deformity. If the affected side is so contracted as to prevent its being occupied by a portion of the presenting part, we have for all practical purposes a generally contracted pelvis, and engagement, if it can occur at all, will take place more readily when the biparietal diameter of the head is in relation with the long oblique diameter of the superior strait. But even after descent has occurred, all obstacles to labor have by no means been overcome, since in many cases the inward projection of the ischium may lead to abnormalities in rotation. Generally speaking, these pelvises are not excessively contracted, Prouvost reporting that 40 out of the 50 cases of labor complicated by them ended spontaneously.

**Treatment.**—As the pelvic contraction is usually not very pronounced, Cæsarean section is rarely indicated, unless the fœtus is large, or the

history of previous labors has shown that the birth of a living child is out of the question. When the obstacle to the engagement of the head is not serious, version gives better results than forceps. This is especially true in coxalgic pelves when the ankylosed leg and the asymmetry of the pubic arch may make its proper application practically impossible.

Pubiotomy is not a justifiable operation in these cases, particularly in those due to coxitis, as we have no means of determining in advance whether the sacro-iliac synchondroses are synostosed; and if such be the case the operation cannot lead to a satisfactory increase in the capacity of the pelvic canal.

#### PELVIC DEFORMITY DUE TO BILATERAL LAMENESS

Occasionally children are born with *luxation of both femora*, the heads of the bones lying, as a rule, upon the outer surfaces of the iliac bones, above and posterior to their usual situation. In some cases the acetabula are entirely absent, but more frequently they are present in a rudimentary condition, new but imperfect substitutes being formed higher up. Strange to say, the condition does not usually seriously interfere with the individual in the matter of learning to walk at the usual age, though the gait is more or less wab- bly.

The pelvic changes resulting from this condition have been studied particularly by Kleinwächter, Schauta, and Sassmann, the latter writer having collected 27 cases from the literature. Owing to the fact that the upward and inward force exerted by the femora is not applied in its usual direction through the acetabula, the pelvis becomes unduly wide, and more or less flattened antero-posteriorly. The transverse widening is particularly marked at the inferior strait, while the flattening, as a rule, is not very pronounced. Thus, the conjugata vera usually measures between 9 and 10



FIG. 634.—SIDE AND REAR VIEW OF PATIENT WITH BILATERAL LUXATION OF FEMORA.



centimeters, and Delmas, after studying 17 cases, concludes that the various diameters are usually enlarged unless the condition is complicated by some other abnormality. Hence, this pelvis rarely offers any serious obstacle to labor.

The patient presents a characteristic appearance, which is suggestive of that observed in spondylolisthesis. Owing to the displacement of the femora the trochanters are more prominent than usual, and the width of the buttocks is increased. At the same time, owing to the increase in the pelvic inclination, there is marked lordosis, the back of the patient appearing considerably shortened and presenting a marked saddle-shaped depression just above the sacrum.

Meyer described a pelvis obtained from an individual who had *double club-foot*, and found that it was markedly funnel-shaped. This condition he attributed to the absence of the usual spring at the foot and ankle-joints, and to the fact that the knees were held fixed during walking. Accordingly, with each step a distinct shock was imparted to the acetabula, instead of the more gentle force which is exerted under ordinary circumstances.

#### ATYPICAL DEFORMITIES OF THE PELVIS

In rare instances the pelvis may be more or less deformed by the presence of bony outgrowths at various points, and less frequently by tumor

formations. *Exostoses* are most frequently observed upon the posterior surface of the symphysis, in front of the sacro-iliac joints, or upon the anterior surface of the sacrum, though in occasional cases they may be formed along the course of the ilio-pectineal line.

Kilian, in 1854, directed attention to the fact that such structures may form sharp, more or less knife-like projections. He designated the condition as *acanthopelys* or *pelvis spinosa*. Such formations are rarely sufficiently large to offer any obstacle to labor, but owing to their peculiar structure may do considerable injury to the maternal soft parts. In fact, in several of the cases reported, they have cut through the lower portion of the uterus.

In rare instances *callus formation*, resulting from inflammatory processes within the pelvis, may attain such proportions as to lead to serious pelvic obstruction, as in a case reported by Ahlfeld.



FIG. 633.—OBSTRUCTION OF PELVIC CANAL BY CYSTIC ENCHONDROMA (Zweifel).

*Tumor formations* of various kinds may spring from the walls of the false or true pelvis and so obstruct its cavity as to render labor impossible. Fibromata, osteomata, enchondromata, carcinomata, and osteosarcomata of the pelvis have been described, and sometimes assume very considerable proportions, and occasionally become cystic. Stadfeld was able to collect 49 such cases in 1879, and Goder 81 cases in 1895. Enchondromata occur more frequently than other varieties of tumor formation, Schopping being able in 1907 to collect 33 well-described cases



FIG. 636.—FRACTURED PELVIS (Mars).

from the literature. He pointed out that such tumors grow especially rapidly during pregnancy and give rise to serious dystocia; 21 Cæsarean sections and 3 destructive operations being necessary in his series of cases.

The prognosis is very grave when the pelvis is obstructed by tumors from its walls, 50 per cent. of the mothers and 89 per cent. of the children having perished in the cases collected by Stadfeld, while in only 11 cases was labor terminated by spontaneous delivery, forceps, or version.

In rare instances healed *fractures* of the pelvis may offer an insuperable obstacle to the birth of the child, owing either to an excessive formation of callus or to the projection of the broken ends of the bones into the pelvic cavity. This condition, however, is very rare, as it is stated that only 0.8 per cent. of all fractures involve the pelvis, and in such cases the internal injuries are usually so severe as to lead to the death of the patient, so that only a small proportion of such women survive, and very few of them become pregnant.

The effect upon labor depends upon the location of the fracture and its manner of healing. Fig. 636 shows a pelvis described by Mars, and gives an idea of the extent of the changes which sometimes result. In a case reported by Neugebauer, in which there was a transverse fracture of the second sacral vertebra, the vertebral column prolapsed into the pelvic cavity and gave rise to a deformity suggestive of spondylolisthesis. For further details the reader is referred to the articles of Schauta, Tarnier, Meurers, and Breus and Kolisko.

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## CHAPTER XXXIX

### DYSTOCIA DUE TO ABNORMALITIES IN DEVELOPMENT OR PRESENTATION OF THE FŒTUS

#### EXCESSIVE DEVELOPMENT

As was stated in Chapter V, the child at birth rarely exceeds 11 pounds (5,000 grams) in weight, though authentic accounts of much larger infants are to be found in the literature.

Provided the pelvis is not contracted, it is very exceptional for a normally formed child, weighing less than 10 pounds (4,500 grams), to give rise to dystocia by its mere size. In overdeveloped children the difficulty is generally due to the fact that the head tends to become not only larger but harder, and consequently less malleable with increasing weight; although it sometimes happens that after the head has passed through the pelvic canal without difficulty the dystocia may be due to the arrest of the unusually large shoulders either at the pelvic brim or outlet.

Excessive development of the fœtus can usually be traced to one of four causes: prolongation of pregnancy, large size of one or both parents, advancing age, or multiparity of the mother.

Cases in which three hundred days or more elapse between the last menstrual period and the onset of labor are not uncommon, and Oyamada states that possible prolongation of pregnancy was noted in 11 per cent. of the 932 children born in the Munich clinic between the years 1885 and 1910 whose weight exceeded 9 pounds (4,000 grams). In the majority of such cases, however, it is only apparent, and merely means that fertilization took place just before the first period missed, instead of shortly after the last menstrual flow. On the other hand, actual prolongation is occasionally observed, and may exert a serious influence upon the course of labor, inasmuch as the child increases in size for every additional day it remains in the uterus. Accordingly, whenever labor fails to occur within a few days of the calculated date, the patient should be carefully examined at frequent intervals, so that labor may be induced as soon as there is any sign of disproportion between the size of the head and the pelvis.

More frequently the excessive size of the child is due to the fact that one or both of its parents are unusually large; moreover, it is a matter of common observation that the foetal head in many instances resembles that of its father, large-headed men usually producing children with similar characteristics. The age of the mother has likewise an important influence upon the foetal development. Thus, the children of elderly primiparæ



frequently exceed the ordinary average, and in multiparæ the children are often larger with each successive pregnancy, provided they do not follow in too rapid succession.

As a rule, large children have well ossified skulls. This is more particularly true for males, in whom the biparietal diameter is usually somewhat greater than in female children of the same weight. In such cases the inability of the head to become molded not only interferes with its engagement, but predisposes to certain injuries, such as spoon-shaped depressions of the skull, if artificial delivery becomes necessary.

Although, in the case of a normal pelvis, a moderate increase in the size of the child is usually without great practical significance, when any degree of contraction exists such a condition may make all the difference between an easy and a difficult labor. At the same time, it must be remembered that in multiparous women the dystocia is often due in great part to the loss of tone of the uterine musculature incident to repeated childbearing.

Inasmuch as our means of determining the size of the child, and particularly of its head, are far from accurate, the diagnosis of excessive development is, as a rule, not established until after fruitless attempts at delivery have been made. Nevertheless thorough examination, in which careful palpation and Müller's method of impression are employed, should ordinarily enable the trained obstetrician to arrive at fairly accurate conclusions and prepare him to meet this complication. If the pelvis is normal the failure of engagement in the last weeks of pregnancy in a primipara or the existence of a face, brow, or transverse presentation should suggest the probable existence of pronounced disproportion.

**Treatment.**—If the patient has apparently gone several weeks beyond term, and examination shows that the size of the child is beyond the average, there should be no hesitancy in the immediate induction of labor as a prophylactic measure, such a procedure being particularly indicated in multiparous women whose history shows that excessive foetal development was the cause of the previous difficult labors. On the other hand, if the pregnancy is not prolonged, the condition is rarely suspected by the ordinary practitioner before the outset of labor, and the diagnosis is made only after Nature has shown that she is unable to effect delivery. In such cases it is often difficult to determine upon the best method of dealing with the complication. If careful examination shows that the head is not engaged and is excessively large and well ossified, the advisability of Cæsarean section or pubiotomy should be considered, provided the patient has not been subjected to unavailing attempts at delivery; as radical interference is quite as justifiable in such circumstances as when dystocia is due to the failure of a normal-sized head to pass through a contracted pelvis. On the other hand, if physicians with questionable technique have failed to effect delivery by forceps or version, radical surgical interference is contra-indicated, and craniotomy becomes our sole resource.

When the obstacle to delivery is due to excessive size of the shoulders rather than to the head, labor can often readily be terminated after diminishing the size of the shoulder girdle by cutting through the clavicles with a pair of heavy scissors—*cleidotomy*.

## MALFORMATION OF THE FÆTUS

**Double Monsters.**—For practical purposes 3 groups of double monsters may be distinguished: (1) Incomplete double formations at the upper or lower half of the body (*diprosopus*, *dipagus*); (2) twins which are united together at the upper or lower end of the body (*craniopagus*, *ischiopagus*, or *pygopagus*); (3) double monsters which are united by the trunk (*thoracopagus* and *dicephalus*).

The diagnosis of any one of these conditions is not made until the serious difficulty experienced in attempting delivery has led to careful exploration under anæsthesia with the entire hand, although in many cases the existence of a multiple pregnancy may have been suspected. As such monstrosities frequently present minor deformities as well, the detection of a club-foot, hare-lip, etc., should always direct one's attention to the possible existence of some still more serious abnormality.

Fortunately the delivery of many monstrosities is much more readily accomplished than would appear possible at first sight. In the first place, such pregnancies rarely go on to full term, so that the monstrosity rarely exceeds a normal child in size. In the second place, the connection between the two halves is often of such a character as to permit of sufficient motility between the component parts as to make their successive delivery possible.

On the other hand, in the first group the large size of the doubled portion of the monster may lead to serious mechanical obstacles at the time of delivery. The fused head in a *diprosopus* is, as a rule, much more readily delivered when it forms the after-coming part than when it presents primarily. In the second group a *craniopagus* presenting by the head usually causes only a moderate amount of difficulty; whereas, on the other hand, *ischiopagi* and *pygopagi*, as a rule, call for complicated and difficult manœuvres before delivery can be effected.

In the third group, the delivery of *dicephalic monsters* is facilitated when they present by the breech, as in many cases first one and then the other head can be extracted. On the other hand, in cephalic presentations the two heads may mutually interfere with one another and thus prevent engagement until one has been diminished in size by craniotomy. When engagement of one head occurs delivery can be partially effected by forceps, but as a rule the head cannot be delivered beyond the pubic arch, for the reason that further descent is prevented by the arrest of the second head at the superior strait. Under such circumstances it is advisable to amputate the first head, after which delivery of the rest of the monster is, as a rule, best accomplished by version.

*Thoracopagi* usually offer a less serious obstacle to delivery, for the reason that they are frequently so loosely connected with one another that considerable motility is possible. Indeed, it is not unusual for the two children to present in a different manner. When possible, it is advisable to bring down all four feet at the same time, and to effect extraction in such a way that the posterior head is first delivered. In cephalic presentations the head and body of the first child are expelled, and the second child is



then born very much as in an ordinary twin pregnancy. If, however, the latter presents transversely, its delivery can be effected only by version and extraction.

### DEFORMITIES OF FÆTUS

In this place attention will be directed only to those abnormalities in fetal development which may give rise to difficult labor. An *acardiacus* is a monster which is sometimes developed in single-ovum twin pregnancies as the result of inequalities in the communicating placental circulation. One twin is well developed and normal, while the other is imperfectly formed, and either possesses a rudimentary heart or no heart at all, being designated according to Kehrer as *hemiacardius* or *holoacardius*, respectively. The way in which this is brought about was considered in the chapter on Multiple Pregnancy.

The holoacardiac monsters may occur as *acephali*, *amorphi*, or *acorni*. Of these the most common variety is the *acephalicus* or headless fœtus. Less common is the *amorphous* monster, which possesses neither a head nor extremities, but is round in shape and presents upon its surface a number of small nodules, which represent the rudimentary extremities. The umbilical cord may be attached to any portion of its surface. The interior of the monstrosity contains a rudimentary intestinal tract, cystic cavities, vertebrae, etc., but no trace of a heart. The rarest variety of *acardiacus* is the

*acornus* or trunkless monster, which consists of an imperfectly developed head and a rudimentary body, the umbilical cord being attached to the cervical region.

As a rule such monsters do not attain any notable size, although exceptionally, as the result of obstruction in the umbilical vein, they may become œdematous and give rise to dystocia.

The *anencephalus* or *hemicephalus* is a monster possessing a trunk, but only an imperfectly developed head, from which a large part of the brain and skull is lacking. Ordinarily such beings are of moderate size, but occasionally the shoul-



FIG. 637.—ANENCEPHALUS (Schroeder).

may be so excessively developed as to give rise to serious dystocia. Owing to the absence of the cranial vault the face is very prominent and somewhat extended, the eyes often protrude markedly from their sockets, and the tongue hangs from the mouth. The brain is in a rudimentary condition, and the base of the skull is accessible to the examining finger, so that the sella turcica can be distinguished. Owing to the exposure of the base of the brain and the upper part of the medulla, there is frequently a marked increase in the amount of amniotic fluid, its condition being analogous to that noted in the picture experiments of the

In view of the abnormal shape of the head face presentations are frequently observed, while those of the vertex are less common than with a normal foetus. Transverse and foot presentations are likewise not unusual.

When the monstrosity presents by the face or head a correct diagnosis is frequently made by vaginal touch, the characteristic bulging of the eye being noted in the former, and the absence of the cranial vault and the presence of the sella turcica in the latter presentation.

Delivery, as a rule, occurs much more readily when the monster presents by the breech, for the reason that the imperfectly developed head is not an efficient dilating agent, though in many cases rapid and spontaneous delivery is observed. Even when the enlarged shoulders give rise to dystocia, delivery can usually be accomplished by means of version without any great difficulty.

### HYDROCEPHALUS

In this not very rare condition, the cerebral ventricles are distended by an excessive amount of cerebro-spinal fluid (Fig. 638). As a result the skull becomes much increased in size, frequently attaining several times its normal dimensions, while the brain substance forms a layer only a few millimeters thick beneath it. At the same time the cranial bones are imperfectly developed, the sutures and fontanelles being much wider than usual.



FIG. 638.—DYSTOCIA DUE TO HYDROCEPHALUS (Bumm).

If the enlarged head is not tensely filled with fluid, under the influence of the uterine contractions, it may undergo such changes in shape that its spontaneous expulsion becomes possible. This, however, is so rare a possibility that it should not be reckoned with in determining the treatment to be pursued in a given case. Still less frequently, owing to the pressure to which the head is subjected at the time of labor, the tissues forming a fontanelle or suture may give way, so that the cerebro-spinal fluid can escape, after which the head collapses and spontaneous delivery becomes pos-



sible. In the vast majority of cases, however, the condition gives rise to serious dystocia, which if not promptly relieved will lead to rupture of the uterus and the death of the patient from intra-abdominal hæmorrhage.

In hydrocephalic children, although cephalic presentations predominate, owing to the lack of accommodation between the head and the pelvic canal, the breech is often substituted.

**Diagnosis.**—As a rule the condition is not recognized until several hours of fruitless second-stage pains have demonstrated the existence of an obstacle to delivery. On the other hand, careful examination should ordinarily lead to a correct diagnosis in the last weeks of pregnancy or soon after the onset of labor. In many cases the deformity can be detected by external palpation, the immensely large and movable head being isolated above the superior strait or in the fundus of the uterus. Furthermore, the examiner should always be on the lookout for the presence of fluctuation, while a peculiar crackling sensation can be elicited by pressure upon the skull. I have made a positive diagnosis in this manner upon several occasions without an internal examination.

As soon as the cervix is dilated, vaginal examination will reveal a large head with widely gaping sutures, through which fluctuation can be obtained by appropriate manœuvres. Of course this does not hold good when the child presents by the breech, but here abdominal palpation will reveal the presence of the large fluctuant head in the fundus of the uterus, or just above the superior strait, in case attempts at extraction have been made.

**Prognosis.**—For the child the outlook is uniformly bad, for even if born alive it usually succumbs within a few days, or in the rare cases in which it survives grows up a hopeless idiot. The maternal prognosis depends largely upon the obstetrician. If left to Nature the usual termination is rupture of the uterus; whereas, if the condition be detected and the proper treatment instituted, the results are almost universally favorable.

**Treatment.**—As soon as the cervix has become completely dilated the head should be perforated through one of the wide sutures, in order that the cerebro-spinal fluid can escape and the skull collapse, after which delivery can be effected by the unaided efforts of Nature, or may be accelerated by the employment of the cranioclast. In breech presentations, after the head has been arrested at the superior strait, evacuation of its contents can be readily effected by excising the arch of one of the cervical vertebrae and passing a catheter through the vertebral canal. On account of the nature of the disease and its effect upon the child, craniotomy may be undertaken without hesitancy, even by those who ordinarily do not consider it a justifiable procedure.

In evacuating the hydrocephalic head, it should be borne in mind that, owing to the extreme thinness of the brain, mere perforation is not always synonymous with foetal death. For this reason the perforator should be carried to the base of the skull and vigorously manipulated in order to destroy the medulla, as nothing could be more horrible than the extraction of a living child after such an operation.

## ENLARGEMENT OF THE BODY OF THE FÆTUS

Enlargement of the abdomen sufficient to cause grave dystocia is usually the result of ascites, a very much distended bladder, or of tumors of the kidneys or liver.

Whenever the abdominal distention is marked spontaneous labor is out of the question; but unfortunately the condition usually escapes detection until fruitless attempts at delivery have demonstrated the existence of some obstruction and have led the obstetrician to introduce his entire hand into the uterus in the hope of discovering its nature.

Occasionally a fœtus affected with *general dropsy* may attain such immense proportions that spontaneous delivery is impossible. A number of such cases are recorded in Ballantyne's valuable monograph. In very rare instances the ascites associated with *fœtal peritonitis* may have a similar result, and exceptionally a child suffering from *chondrodystrophia fetalis* may become so cedematous as to give rise to dystocia.

As the result of the dilatation of the superficial lymphatics associated with œdema of the subcutaneous tissues, the fœtus may assume immense proportions and take on a bizarre shape. This condition, which is designated as *elephantiasis congenita cystica*, has been studied in detail by Ballantyne, and is a very rare cause of difficult labor (Fig. 639).

Defective development of the lower portion of the urinary tract may lead to the *retention of urine* accompanied by distention of the abdomen sufficient to render normal delivery impossible (Fig. 640). Examples of this condition have been reported by Walther, Schwyzer, and others, who also give details as to its ætiology.

A much more frequent cause of abdominal enlargement is the presence of *congenital cystic kidneys*. The growth, which is histologically an adenocystoma, may involve one or both organs, and give rise to tumors of immense size. The condition is frequently associated with dilatation of the



FIG. 639.—ELEPHANTIASIS CONGENITA CYSTICA (Ballantyne).



ureters, and with dropsical effusions into the various body cavities. Fig. 641 gives an idea of the extent of the abdominal enlargement in a child



FIG. 640.—FŒTUS WITH IMMENSELY DISTENDED BLADDER (Hecker).



FIG. 641.—FŒTUS WITH CONGENITAL CYSTIC KIDNEYS.

which I delivered, and which was described by Lynch in 1906, together with an analysis of 50 other cases reported in the literature.

In rare cases the abdominal enlargement may be due to *tumors of the liver*, Porak and Couvelaire having reported a case of congenital cystic liver associated with a similar condition of the kidneys. Moreover, large tumors, arising from any of the abdominal organs, may give rise to dystocia. Thus, Rogers has described an immense *fibro-cystic testicle*, and Phaenomenow an aortic aneurysm so large as to interfere with delivery. In rare instances foetal inclusions, such as the so-called *fœtus in fœtu*, may be responsible. Occasionally the invasion by *Bacillus aerogenes capsulatus* may be followed by such an extensive production of gas that the size of the foetus becomes more than doubled, when spontaneous delivery is impossible.

In all of these conditions, if the dystocia is marked, delivery can be accomplished only after opening the body of the foetus and allowing the fluid to escape, or removing a portion, at least, of

the offending tumor formation. The latter operation is not always easy, for, owing to the constrained position of the hand *in utero* and the dense consistency of the growth in many cases, great difficulty may be experienced.

In rare instances abnormal growths arising from various portions of the body of the fœtus may seriously interfere with delivery. Cases are on record in which lipomata, carcinomata, angiomata, and various other tumors have given rise to such an enlargement that spontaneous delivery became out of the question. Exceptionally, dermoid cysts and teratomatous tumors about the perineum and sacrum may offer a serious obstacle. Fig. 275 represents a fœtus in which an adenoma of the thyroid gland necessitated a destructive operation. In rare instances parasitic fœtal tumors, a large umbilical hernia, a spina bifida, and other growths give rise to difficult labor.

#### DYSTOCIA DUE TO ABNORMAL PRESENTATIONS OF THE FŒTUS

**Transverse Presentations.**—In this condition the long axis of the fœtus crosses that of the mother at about a right angle. When it forms an acute



FIG. 642.—DIAGRAM SHOWING LEFT ACROMION DORSO-POSTERIOR PRESENTATION.



FIG. 643.—DIAGRAM SHOWING RIGHT ACROMION DORSO-ANTERIOR PRESENTATION.

angle we speak of an *oblique* presentation. The latter, however, is usually only transitory, becoming converted into a longitudinal or transverse presentation when labor supervenes.

In transverse presentations the shoulder usually occupies the superior strait, the head lying in one and the breech in the other iliac fossa (Figs. 642 and 643). Accordingly, such a condition is commonly spoken of as a *shoulder*, less frequently as a *lateral plane*, and technically as an *acromion* presentation. The latter designation is chosen for the reason that the acromion process is one of the most characteristic features of the shoulder, the position being right or left according to the side of the mother toward which the shoulder is directed. Moreover, as, in either position, the back may be directed either anteriorly or posteriorly, it is customary to distinguish between the *dorso-anterior* and *dorso-posterior* varieties. The recognition of the position of the back is of very considerable importance in connection with the proper performance of version—the treatment *par excellence* in this condition.



According to Schroeder, the shoulder is directed toward the left side of the mother 2.6 times more frequently than toward the right, while the back looks anteriorly 2.5 times more frequently than posteriorly.

*Ætiology.*—The existence of a transverse presentation in a primiparous woman is *prima facie* evidence of a lack of accommodation, usually the result of disproportion between the size of the head and the pelvis, though occasionally it may be due to hydramnios. In multiparæ, on the other hand, the most frequent ætiological factor is an abnormal relaxation of the abdominal and uterine walls, the result of repeated childbearing, which may be still further complicated by any of the causes already enumerated. Accordingly, transverse presentations are much more frequently observed in women who have borne a number of children, and in them, as a rule, the condition is less serious, for the reason that spontaneous reposition sometimes ensues after the onset of labor pains, the child assuming a longitudinal presentation, whereas such an occurrence is very exceptional in primiparæ.

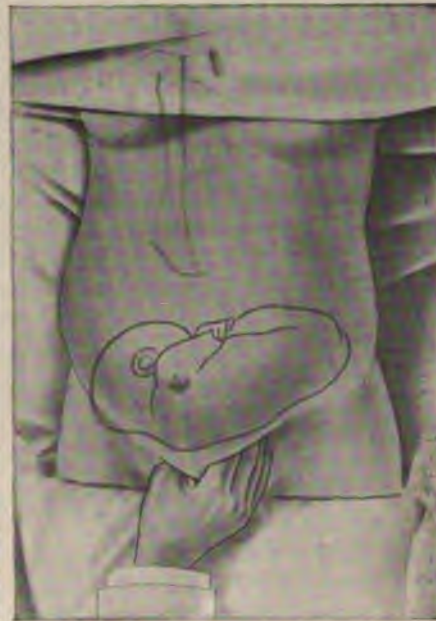
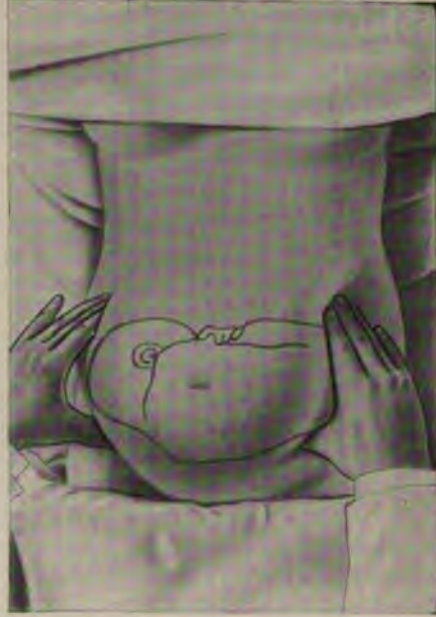
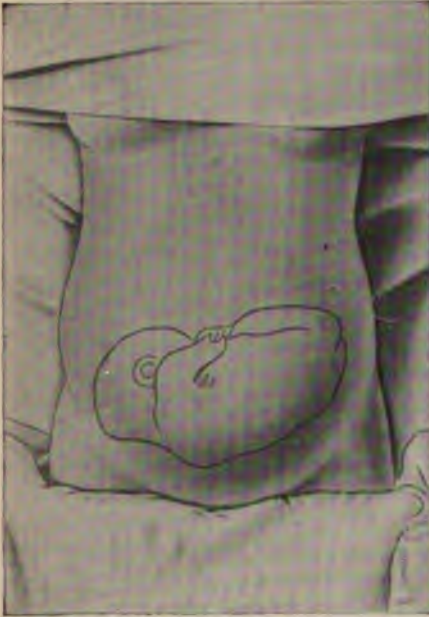
Spontaneous version is very improbable after rupture of the membranes, and is rendered very difficult by any condition which interferes with the descent or engagement of the head; as, for example, a contracted pelvis, placenta prævia, a pelvic tumor, or twin pregnancy. Very exceptionally, longitudinal may become converted into secondary transverse presentations at the time of labor, and such an occurrence is always indicative of disproportion between the size of the child and the pelvis.

*Diagnosis.*—The diagnosis of a transverse presentation is usually readily made, inspection alone frequently causing one to suspect its existence. The abdomen is seen to be unusually wide from side to side, while the fundus of the uterus frequently does not extend above the umbilicus.

On palpation the first manœuvre reveals the absence of the head or the breech from the fundus. On the second manœuvre a ballottable head will be found in one and the breech in the other iliac fossa, while the third and fourth manœuvres are negative, unless labor has been in progress for some time and the shoulder has become impacted in the pelvis. At the same time the position of the back is readily diagnosed. When it is situated anteriorly a hard resistant plane will be felt extending across the front of the abdomen; when it lies posteriorly irregular nodulations, representing the small parts, will be felt in the same location (Plate XV).

On vaginal touch in the early stages of labor, the side of the thorax, readily recognizable by the "gridiron" sensation afforded by the ribs, can be made out at the superior strait. When dilatation is further advanced the scapula can be distinguished on one and the clavicle on the other side of the thorax, while the position of the axilla will indicate toward which side of the mother the shoulder is directed. Later in labor the shoulder becomes tightly wedged in the pelvic canal, and a hand and arm frequently prolapse into the vagina; whether it is the right or left can be readily determined by ascertaining to which one of the obstetrician's it corresponds, just as in shaking hands.

PLATE XV.



PALPATION IN RIGHT ACROMIO, DORSO-ANTERIOR PRESENTATION.





*Course of Labor.*—With very rare exceptions the spontaneous birth of a fully developed child is impossible in persistent transverse presentations, since expulsion cannot be effected unless both the head and trunk of the child enter the pelvis at the same time, which is manifestly impossible. Accordingly, both the fœtus and mother must almost inevitably perish if appropriate measures are not instituted. On the other hand, small premature, and particularly macerated, children are frequently born spontaneously.

After rupture of the membranes, if the patient is left to herself an arm usually prolapses and the shoulder becomes forced down into the pelvic cavity, but can descend for only a certain distance, being arrested by the head and trunk at the superior strait. The uterus then contracts vigorously in the attempt to overcome the obstacle, but in vain. After a certain time the contraction ring rises higher and higher, the lower uterine segment becomes more and more stretched and eventually gives way, when a part or the whole of the product of conception escapes into the abdominal cavity. In such circumstances the patient usually succumbs within a short time to intraperitoneal hæmorrhage, while in other instances death occurs after a longer or shorter period from infection.

Possibly once in many thousand cases, the uterus may cease to contract before the membranes rupture, and the child, being retained within the uterus, may eventually become mummified or converted into a lithopædion. Such a missed labor is very rare in human beings, though it is well known to the veterinarians. On the other hand, such an occurrence would be out of the question had the amniotic sac been opened, as in such circumstances bacteria would gain access to the uterus and give rise to infection, which, if not terminating in the death of the patient, would lead to the gradual casting off of the product of conception by suppurative processes, supposing that the woman could be so long neglected.

In transverse presentations, now and again, spontaneous delivery ensues. Bartholin, in the seventeenth century, pointed out that a child which has lain transversely during the later months of pregnancy may spontaneously assume a longitudinal presentation at the time of labor. This so-called *spontaneous version* is a not infrequent occurrence. Its mode of production has already been referred to.

A century later Roederer pointed out that in rare instances, if the child was very small and the pelvis large, spontaneous delivery might occasionally be accomplished in spite of the persistence of the abnormal presentation. In such cases the child becomes compressed upon itself with the head tightly pressed against the abdomen, so that a portion of the thoracic wall below the shoulder becomes the most dependent part and appears at the vulva. The head and thorax then pass through the pelvic cavity at the same time, and the child, which is doubled upon itself, is expelled—*conduplicato corpore*. Manifestly, such a mechanism is possible only in the case of very small children, and is occasionally observed when the second child in twin pregnancy is prematurely born.

In very rare instances, a dead child of moderate or average size may be expelled spontaneously by another mechanism, which is designated as



*spontaneous evolution.* This, however, is met with so rarely, demands such peculiar conditions, and is attended by such risks to the mother that its occurrence should never be counted upon in actual practice, although very occasionally in neglected cases it may occur unexpectedly and even rapidly, a 2,700-gram child being born 8 hours after the onset of labor in the only case of the kind occurring in my experience.

This mode of delivery occurs once in every several hundred transverse presentations, and its mechanism has recently been studied by Payer, Zangemeister, and Franz. It is possible only after the cervix has become completely dilated, and the shoulder impacted into the superior strait, in women with vigorous uterine contractions. It may be effected by either one



FIG. 644.—FROZEN SECTION THROUGH WOMAN DYING IN LABOR WITH A NEGLECTED TRANSVERSE PRESENTATION (Chiara).

of two mechanisms, which are designated as those of Douglas and of Denman, after the observers who first described them. In the more frequent mechanism of Douglas, one arm is always prolapsed and the strong contractions force the shoulder to the vulva. While this is being effected the child rotates in such a manner as to bring the head to the front, where it is arrested at the pelvic brim. If the neck is sufficiently long or elastic, the shoulder is partially forced out under the pubic arch and is followed by the trunk, buttocks, legs, and finally the head (Fig. 645). Delivery by this mechanism would probably have been effected in Chiara's case had the patient survived. (Fig. 644.)

On the other hand, in the less frequent mechanism of Denman, the conditions are less favorable, as the buttocks are obliged to pass through the pelvic cavity while it is still occupied by the thorax, with the result that both the shoulders and breech emerge from the vulva simultaneously. (Fig. 646.)

*Prognosis.*—If spontaneous version does not occur within the first few hours after the onset of labor, and operative procedures are not instituted,

spontaneous evolution offers the only possibility for spontaneous delivery; and as this occurs so rarely as to be negligible the outcome for both mother and child is almost uniformly fatal, the child succumbing to asphyxia and the mother to hæmorrhage or infection, as a result of rupture of the uterus. On the other hand, if appropriate measures are instituted, the prognosis for the child is fair, while for the mother it is excellent. In this class of cases prolapse of the cord is one of the most frequent causes of foetal death.

*Treatment.*—If the diagnosis has been made in the last month of pregnancy and the pelvis is approximately normal, cephalic version should be effected by external manipulations, and the child held in its new position by means of a properly fitting bandage. On the other hand, if the pelvis



FIG. 645. — DIAGRAM ILLUSTRATING SPONTANEOUS EVOLUTION, DOUGLAS'S MECHANISM (Zangemeister).

is markedly contracted, such a procedure is not advisable, as Cæsarean section at an appointed time will be the operation of choice.

If the patient is not seen until after labor has set in external cephalic version should likewise be attempted, provided the membranes have not ruptured. As a matter of fact, however, such manipulations will usually prove unsuccessful. In this event one should wait until the cervix is almost completely dilated, and then, after rupturing the membranes, perform internal podalic version, followed by prompt extraction.

On the other hand, if the patient be not seen until she is well advanced in labor and the membranes have ruptured, the treatment will vary according to the degree of dilatation of the cervix, the condition of the patient, as well as that of the foetus and uterus. If the cervix is only partially dilated, while the child is alive and freely movable in the uterus, bipolar version may be attempted. After a foot has been brought down the cervix should



spontaneous extraction is completed. On the peculiar complication by prolapse of the cord, the occurrence of this condition and the child rapidly extracted after occasional cases of this kind. Internal podalic version should be a 2,700-gm. child, the rules already given, and followed by case of the child.

This version is not so tightly contracted down present to the pelvic segment so thinned out that such a pro-Zangenmeister's procedure. Even in such cases anaesthesia completely effected, although the version may be safely effected, although women with this condition is out of the question.

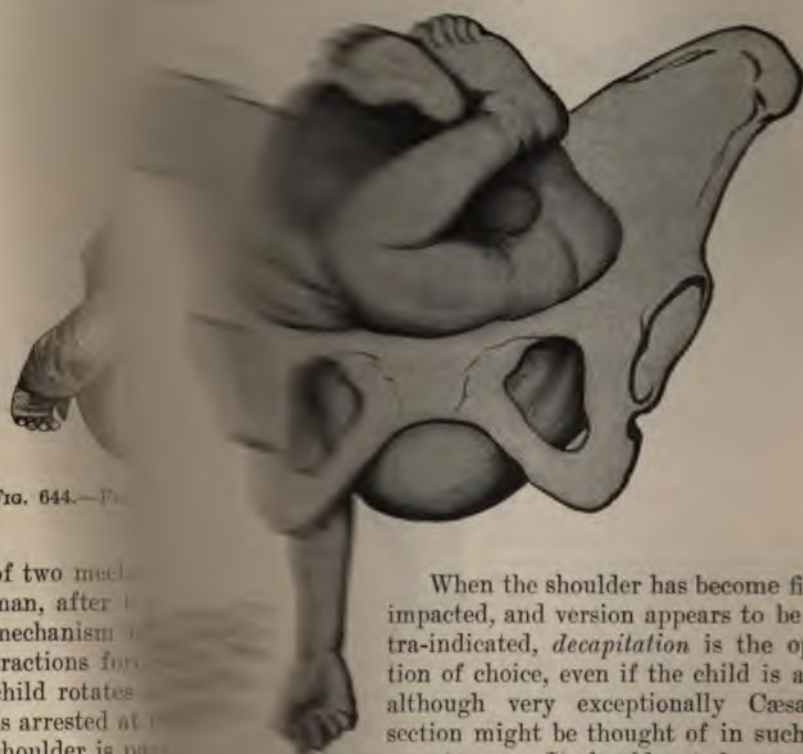


FIG. 644.—Fetus

of two months of gestation, after the mechanism of contractions for the child rotates and is arrested at the shoulder is part of the trunk, buttocks, and mechanism would not survive.

On the other hand, conditions are less favorable for the pelvic cavity while both the shoulder and the head are in the pelvis (Fig. 646.)

**Prognosis.**—If the child is born within hours after the onset of labor, the prognosis is

When the shoulder has become firmly impacted, and version appears to be contra-indicated, *decapitation* is the operation of choice, even if the child is alive; although very exceptionally Caesarean section might be thought of in such circumstances. It should not, however, be

express wish of the patient and her family, and made fully conversant with its inherent danger, who in all probability is already infected.

—By this term is understood the prolapse of the presenting part, both entering the pelvic cavity, is not an infrequent occurrence, being observed in 1 per cent. of cases (Fig. 647).

arm comes down with the head; much less common and a foot, or both feet may present together. In which the neck of the child was girdled by its

legs, so that the scrotum and head were felt upon vaginal examination (Fig. 648).

Some idea of the relative frequency of the different combinations may be gained from the following table, taken from Pernice:

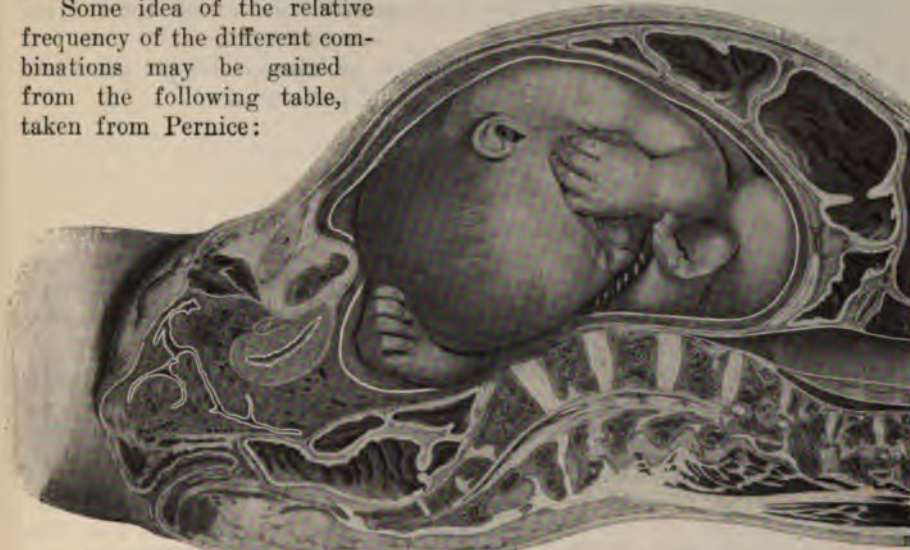


FIG. 647.—FROZEN SECTION THROUGH WOMAN DYING AT END OF PREGNANCY. COMPOUND PRESENTATION (Braune).

|                                          |          |
|------------------------------------------|----------|
| Head and hand.....                       | 26 cases |
| Head and arm.....                        | 8 “      |
| Head, hand, and cord.....                | 5 “      |
| Head and both hands.....                 | 4 “      |
| Head, one hand, and one foot.....        | 2 “      |
| Head, two hands, one foot, and cord..... | 1 case   |
| Face, hand, and cord.....                | 1 “      |

Such a condition is frequently associated with disproportion between the size of the head and the pelvis, owing to which early engagement has been interfered with, and as a result one or more of the extremities have prolapsed before the presenting part entered the pelvis.

*Treatment.*—Whenever, during the first stage of labor, a hand is distinguished alongside of the head, it should be pushed up if possible; but if it be firmly fixed between the head and the pelvic wall it should be left alone, since it will usually not interfere with labor. On the other hand, if the entire arm is prolapsed alongside of the head, an energetic effort



FIG. 648.—COMPOUND PRESENTATION



should be made to replace it. If this is not possible, version should be performed, since if the arm retains its position it may give rise to serious dystocia, more especially if it extends around the child's neck, constituting the so-called *nuchal position*.

When, as happens only rarely, the foot prolapses, attempts should be made to replace it; if these fail version should be resorted to.

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## CHAPTER XL

### HÆMORRHAGE

A profuse hæmorrhage occurring prior to or shortly after the birth of the child is always a dangerous and sometimes a fatal complication. Practically all varieties of *ante-partum hæmorrhage*, with the exception of those originating from lacerations of the genital canal, are due to a partial or complete separation of the placenta from its attachment to the uterine wall. This accident is an inevitable accompaniment of labor when the placenta is implanted in the neighborhood of the internal os—*placenta prævia*, but occasionally occurs when the organ occupies its normal site in the upper portion of the uterus.

#### PREMATURE SEPARATION OF THE NORMALLY IMPLANTED PLACENTA

From the time of Hippocrates it had been customary to ascribe all cases of *ante-partum hæmorrhage* to this accident, but, with the recognition of the nature of *placenta prævia* and the knowledge that its separation is unavoidably associated with hæmorrhage, the earlier view was abandoned and the former accident came to be regarded as of rare incidence.

Goodell, in 1870, collected 106 instances from the literature, while Holmes, in 1901, was able to find 200 additional cases. The latter, however, believes that these figures give a very inadequate idea of the frequency of the accident, and considers that it occurs about once in every 500 labors. His contention is confirmed by Lyle's statistics, which show that 40 cases were observed in the Rotunda Hospital of Dublin during the ten years ending with 1899. On the other hand, Lobenstine and Harrar noted the complication less frequently, having reported 47 cases in 42,000 labors at the New York Lying-in Hospital, an incidence of 1 to 894. My own experience leads me to believe that Holmes's estimate is approximately correct.

**Ætiology.**—Unfortunately, the primary cause of the premature separation of the placenta is imperfectly understood, although a number of theories have been advanced concerning it. In 67 of Holmes's cases there was a history of a preceding traumatism which, according to Coe, is the most common ætiological factor. On the other hand, this was noted in only ten per cent. of the series of cases reported by Lobenstine and Harrar, and was lacking in all of my own cases. Most German authorities attribute the accident to inflammatory changes in the decidua, which were present in



every one of the 8 cases examined by Weiss, although in 2 of them the predominant lesion was a suppurative metritis. Schickele, on the other hand, found no signs of endometritis, but described a pronounced degeneration of the decidua in the cases which he studied.

Winter believes that a close relationship exists between nephritis and premature separation of the placenta, and many authors have subscribed to this opinion. Lobenstine and Harrar, however, were able to demonstrate albuminuria in only 30 per cent. of their cases, and it would appear probable that in many instances, at least, such a combination is purely accidental; for, if renal lesions played anything like the prominent part assigned to them by Winter and his followers, premature separation of the placenta



Fig. 649.



Fig. 650.

FIGS. 649, 650.—PREMATURE SEPARATION OF PLACENTA WITH EXTERNAL HÆMORRHAGE (Winter).

would be frequently observed, since nephritis complicating pregnancy is by no means uncommon.

Multiparity would appear to be a predisposing cause, only 19.2 per cent. of the cases collected by Holmes having been noted in primiparæ. Moreover, the frequency of the accident increases directly with the number of pregnancies, and the advocates of the endometritis theory believe that these facts add to the force of their argument.

Any of these conditions may come into play during pregnancy or at the time of labor. On the other hand, certain ætiological factors cannot become operative until labor has set in. Among these may be mentioned traction exerted by an abnormally short umbilical cord, as well as a sudden diminution in the bulk of the uterine contents following the birth of the first child in a twin pregnancy or the too rapid expulsion of a large amount of amniotic fluid in hydramnios.

**Pathology.**—As the result of the separation of the placenta the vessels

traversing the decidua serotina are torn through and, since the uterus, which is still distended by the product of conception, is unable to retract in the usual manner and compress them, hæmorrhage must inevitably result. The blood may make its way to the exterior or be retained within the uterus. According to Goodell, the latter condition, which constitutes what is termed *concealed hæmorrhage*, is liable to occur (1) when there is an effusion of blood behind the placenta, its margins still remaining adherent; (2) when the placenta is completely separated, while the membranes retain their attachment to the uterine wall; (3) when the blood gains access to the amniotic cavity after breaking through the membranes; and (4) when the head is so accurately applied to the lower uterine segment that the blood cannot make its way past it. In about two thirds of the cases, however, the membranes are dissected off and the blood eventually escapes from the cervix. Thus, in the series of 306 cases collected by Goodell and Holmes, the hæmorrhage was external in 193 and concealed in 113.

Rigby, in 1780, directed particular attention to this condition, and designated the hæmorrhage resulting from it as *accidental*, as contrasted with the *unavoidable* hæmorrhage following the partial separation of a placenta prævia. In many instances the prematurely separated organ may be seriously damaged by the hæmorrhage; and especially in the cases complicated by albuminuria a large part of its bulk is often found occupied by fresh red infarcts or placental apoplexies. In other cases, however, the only anatomical indication of the condition visible in the placenta will be a few large blood-clots adhering to its maternal surface or to one of its margins.

**Clinical History.**—Premature separation of the placenta may occur during the later months of pregnancy or at the time of labor. In the former case the resulting external or concealed hæmorrhage is soon followed by the onset of uterine contractions. In either event, if the loss of blood is marked, the patient presents signs of acute anæmia, and passes into a condition of profound shock which may end fatally if delivery is not effected promptly. Wright contends that the shock is more often the result of traumatism than that of actual hæmorrhage, and may pass off under appropriate medicinal treatment.

In concealed hæmorrhage the uterus gradually becomes of a size considerably larger than would normally correspond to the duration of the pregnancy, and assumes an almost ligneous consistency, so that the results of palpation become very indefinite. At the same time the patient complains of intense pain. On the other hand, when the hæmorrhage is external, there is little or no enlargement of the uterus, and the pain is less severe. In the former case the pain and shock are often attributed to other conditions, and the patient is sometimes left to die undelivered.

When the premature separation of the placenta occurs at the time of labor as the result of traction upon an abnormally short cord, or of the sudden partial emptying of the uterine cavity in twin pregnancy or hydramnios, external hæmorrhage generally occurs, and the foetal heart sounds become imperceptible.

In very exceptional instances the placenta may become separated from



its attachment during the course of an otherwise normal labor, and be extruded in front of the child. No doubt most of the recorded cases were really instances of placenta prævia, although now and again, as in the case reported by Münchmeyer, such an accident may occur even when the placenta is inserted normally—*prolapse of the placenta*.

**Diagnosis.**—The appearance of acute anæmia, with manifestations of shock, in a patient in the later months of pregnancy should always suggest the possibility of concealed intra-uterine hæmorrhage, though similar symptoms may follow the rupture of an advanced extra-uterine pregnancy, or the very exceptional cases of spontaneous rupture of the uterus. In many instances the diagnosis is placed beyond doubt by the large size of the uterus and its ligneous consistence, though usually it is arrived at mainly by exclusion.

When, however, the hæmorrhage is external, the diagnosis is rendered practically positive by the failure to demonstrate the presence of a placenta prævia, though, of course, it is impossible to differentiate the rare cases of rupture of the circular sinus of the placenta to which Budin has directed our attention. When the accident occurs during labor and is attended by some loss of blood, the symptoms are suggestive of those following rupture of the uterus, though the latter accident rarely occurs except after a prolonged second stage, while premature separation may occur at any period.

In the exceptional instances in which the hæmorrhage is entirely retro-placental a localized elevation of the corresponding portion of the uterine wall can occasionally be detected on palpation.

**Prognosis.**—Accidental hæmorrhage, whether external or concealed, is one of the most serious complications of pregnancy and labor, practically all of the children and many of the mothers perishing. Thus, Goodell, Holmes, and Lobenstine and Harrar reported a maternal and foetal mortality of 50.9 and 94.4 per cent., of 32.2 and 85.8 per cent., and of 17 and 77 per cent., respectively.

**Treatment.**—In the more marked forms the life of the mother can be saved only by prompt evacuation of the uterus. On the other hand, when the separation is partial and the loss of blood but slight, the accident may be without serious significance. In the latter class of cases an expectant treatment should be pursued, and labor allowed to take its natural course, interference being indicated only when the symptoms become urgent. On the other hand, if the patient presents signs of acute hæmorrhage, whether of the concealed or external variety, the uterus should be emptied with the least possible delay, in order that it may retract and thus compress the bleeding vessels.

If labor has not yet set in, and the symptoms are urgent, the treatment will depend upon whether the patient is in a hospital or not. In the former event abdominal or vaginal Cæsarean section should be performed; while in the latter event the cervix should be dilated instrumentally to a sufficient extent to permit the introduction of a Champetier de Ribes balloon, and, as soon as the internal os has become obliterated, further dilatation should be effected by Harris's method. If, however, labor is already in progress and

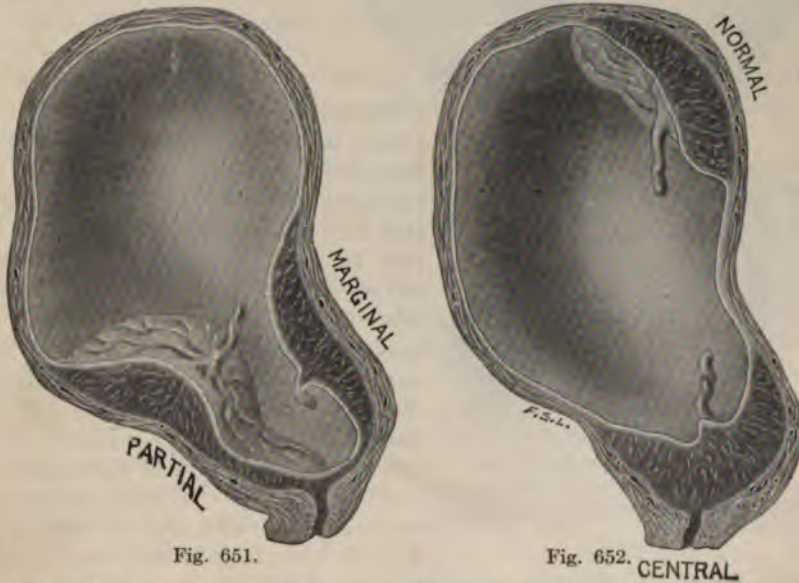
the cervical canal has become in great part obliterated, manual dilatation should be employed from the outset and the child promptly delivered by version or forceps, as appears most advisable. It of course goes without saying that the various measures appropriate for combating shock should be employed as adjuvants to the purely obstetrical treatment.

In some instances the tonicity of the uterus has been so impaired by the loss of blood and the distention to which it has been subjected that it fails to contract and retract during the third stage of labor, and as a result profuse post-partum hæmorrhage may follow. This possibility should always be borne in mind, and the operator should have in readiness the necessary materials for packing the uterus at a moment's notice.

### PLACENTA PRÆVIA

The most common cause of ante-partum hæmorrhage is the partial separation of a placenta implanted in the neighborhood of the internal os—placenta prævia.

Our knowledge concerning this abnormality may be said to date from



FIGS. 651, 652.—SHOWING DIFFERENT MODES OF PLACENTAL INSERTION.  
(Modified from American Text-Book.)

the end of the seventeenth and the beginning of the eighteenth centuries, Portal, in 1685, and Schacher, in 1709, having accurately described the condition from a clinical and an anatomical point of view. Notwithstanding the fact that Smellie, William Hunter, and Rigby were well acquainted with placenta prævia and its dangers, very little advance was made in our knowledge concerning it until Barnes promulgated his views as to its mode of production and the methods of controlling the hæmorrhage arising from



it. Since then many investigators have busied themselves in searching for its mode of origin and the most suitable treatment. An excellent historical résumé is contained in the monographs of von Herff and Hofmeier.

In this condition, the placenta, instead of being implanted high up upon the anterior or the posterior wall of the uterus, overlaps the internal os to a greater or lesser extent, thereby becoming accessible to the examining finger. Ordinarily, three varieties are distinguished: *Placenta prævia centralis*, *lateralis* or *partialis*, and *marginalis*. In the first the

internal os is completely covered by placental tissue, which is adherent to its margins; in the second the placenta encroaches more or less upon the internal os, but does not completely cover it; while in the third the placenta is implanted higher up, its lower margin just overlapping the internal os (Figs. 651 and 652).

Strictly speaking, the differentiation between the several varieties should not be made until the cervix has become fully dilated, for the reason that the marginal variety cannot be felt until this has occurred; while what may appear to be a complete placenta prævia during pregnancy and the first part of labor may prove to be only partial, and to encroach only a little beyond the margin of the internal os when dilatation is complete. In both the central and partial varieties, partial separation of the placenta is an inevitable consequence of the formation of the lower uterine segment and the dilatation of the cervix.

This is always associated with hæmorrhage, which was therefore designated by Rigby as *unavoidable*. In placenta prævia marginalis, on the other hand, hæmorrhage does not always occur, and, as the placental tissue can be felt only after dilatation has proceeded to a certain extent, the existence of the condition is frequently unrecognized. Such cases are closely related to the so-called *vicious insertion* of the placenta described by Pinard and his pupils, which is of frequent occurrence.

**Frequency.**—Placenta prævia is fortunately a comparatively rare complication, although the statements as to its frequency vary considerably. Thus, W. Müller, whose statistics were based upon 876,432 labors, stated that it

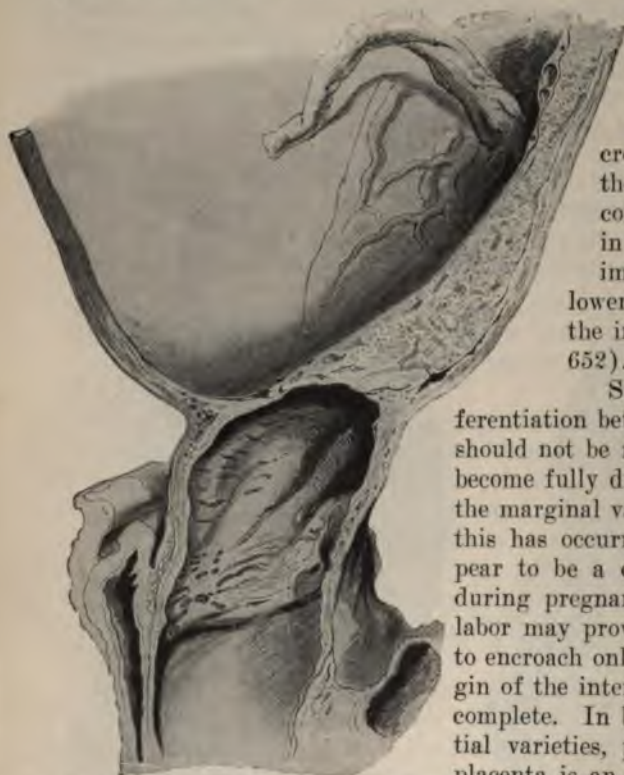


FIG. 653.—PLACENTA PRÆVIA, IN WHICH NO ATTEMPT AT DELIVERY HAD BEEN MADE (Ahlfeld)

occurs once in 1,078 cases; while Lomer, Tarnier, and Bürger and Graf, on the other hand, estimated its incidence as once in 723, 207, and 130 labors respectively. In all probability it would be correct to say that it is met with about once in 1,000 cases in private, as compared with once in 250 cases in hospital practice.

Moreover, there is considerable variation in the statements concerning the relative incidence of the several varieties, though it is generally admitted that the partial form is the most frequent. Thus, Koblanck, Strassmann, and Bürger and Graf observed the central variety in 18.4, 23.8, and 18.4 per cent., the partial in 64.5, 61.5, and 36 per cent., and the marginal in 17.1, 15.2, and 45.6 per cent. of their placenta prævia cases respectively. Pinard, on the other hand, states that he has never met with a placenta which was uniformly adherent to the margins of the internal os, and that the marginal is the most frequent variety. In favor of this view he adduces the fact that he had observed the so-called vicious insertion in 28.12 per cent. of all normal labors. His conclusions must, however, be accepted with reserve, since they are based upon the measurement of the distance of the margin of the placenta from the point of rupture of the membranes, as determined from the examination of the after-birth, and it is clear that such a mode of investigation is not above reproach.

**Ætiology.**—Concerning the ætiology of placenta prævia comparatively little is known. Two factors, however, appear to favor its occurrence—multiparity and endometritis.

The abnormality occurs comparatively rarely in primiparæ, and increases in frequency with the number of children which the individual has borne. This point is strikingly illustrated by the following figures of Doranth, which are based upon 30,796 labors occurring in Chrobak's clinic. He noted placenta prævia in 0.17, 0.48, 1.37, 1.28, and 3.39 per cent. of the patients, according as they had given birth to 1, 2, 3, 4, 5, or 6 children respectively; whereas, when the number of children varied between 7 and 10, the percentage was 5.51.

The occurrence of placenta prævia is not only favored by the absolute number of children, but also by the rapidity with which the labors have followed one another, Strassmann finding that the average age of his patients was 32.9 years, and that the average number of labors was 6.38.

Strassmann also pointed out that one of the most important factors in its development was to be found in defective vascularization of the decidua, the result of inflammatory or atrophic changes, the latter being favored by repeated and closely following pregnancies. Such conditions, he maintained, limit the amount of blood going to the placenta, so that in order to obtain its requisite supply of nutriment it becomes necessary for it to spread over a greater area of attachment, and in so doing its lower portion occasionally approaches the region of the internal os, completely or partially overlapping it as the case may be. Plausibility is lent to such a view by the fact that the placenta in this abnormality is spread over a greater area of the uterus than usual, while at the same time it is often considerably thinner. Thus, in one of my cases which came to autopsy, the placenta



was almost membranous, and its site occupied four-fifths of the interior of the uterus.

**Mode of Formation.**—The older authorities believed that placenta prævia was due to the separation from its attachment of a normally implanted ovum, which, falling to the lower portion of the uterus, contracted new connections just before escaping through the cervix. Later it was urged that such a view failed to explain the production of the central variety, as it was inconceivable that the minute ovum could be prevented from escaping from the uterus sufficiently long to permit the formation of attachments between it and the margins of the internal os. The fallacy of this view

becomes apparent when one recalls the fact that, with the uterus in its normal anteflexed position, the region of the internal os is frequently at a higher level than the fundus, and consequently the force of gravity would not necessarily aid in carrying the ovum through the cervix. Furthermore,

Bumm, in 1905, contended that, in view of the congested condition of its margins, the internal os is smaller than the fertilized ovum, and that therefore no fundamental reason exists why it should not become implanted in that locality.

The former view was generally accepted until 1888, when Hofmeier and Kaltenbach advanced the theory that a part of the placenta developed from a portion of chorion in contact with

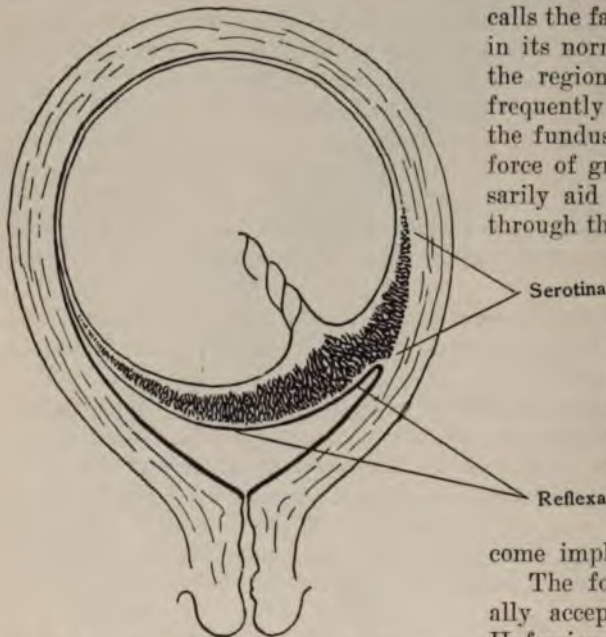


FIG. 654.—DIAGRAM ILLUSTRATING HOFMEIER'S THEORY OF THE FORMATION OF PLACENTA PRÆVIA.

the decidua reflexa. As pregnancy advanced this so-called *reflexa placenta* gradually bridged over the internal os and eventually came in contact and fused with the decidua vera, after which vascular connections with the uterine wall became established (Fig. 654).

This view at once met with very favorable consideration, and Jolly, in 1911, advanced incontrovertible proof of its correctness in many cases. When Hofmeier advocated this mode of origin at the 1897 meeting of the German Gynecological Congress, he was careful to state that it was not the only manner in which a placenta prævia might originate; inasmuch as in certain instances the extension of the placental area might be effected by a process of cleavage in the decidua vera, as the result of which the margin of the organ would extend beyond the serotina. Should such a process extend

downward, it was readily conceivable that the placenta might grow on either side of the internal os, and, as the latter became obliterated, completely cover it. At that time our present views concerning the mode of implantation of the ovum and of the growth of the placenta were not held, so that Hofmeier was not aware that an analogous process occurs in every normal pregnancy. Ahlfeld and Aschoff, in 1904, admitted the correctness of this explanation, and stated that the cleavage might extend so far as to give the impression that a part of the placenta, at least, had developed in the wall of the cervix.

In view, therefore, of our present knowledge concerning the normal implantation of the ovum, as well as of Strassmann's theoretical deductions, it appears probable that placenta prævia results either from the primary implantation of the ovum in the lower portion of the uterus, associated with an extensive cleavage of the decidua vera, by which the extension of the placenta to the region of the internal os is facilitated, or to its partial development over the decidua reflexa or capsularis.

Very exceptionally, as reported by von Weiss, Ponfick, Kermanner, and Labhardt, a part of the placenta is developed upon the upper portion of the cervix. The possibility of such an occurrence must be admitted, although Ahlfeld and Aschoff have shown that it is more apparent than real, as the condition is not due to a primary implantation, but rather to a secondary cleavage of the cervix by the extension of a placenta which had been primarily implanted above it.

**Symptoms.**—The most characteristic symptom of placenta prævia is hæmorrhage, which usually does not appear until after the seventh month of pregnancy. At the same time it is probable that many abortions are due to this condition, although the true state of affairs usually escapes observation. I have seen several abortions in the third month which were clearly due to this abnormality.

The hæmorrhage frequently comes on without warning in a pregnant woman who had previously considered herself in perfect health. Occasionally it makes its first appearance while the patient is asleep, so that on awakening and feeling the bedclothes moist, she is surprised to find that she is lying in a pool of blood. Ordinarily, the initial bleeding ceases spontaneously, to recur again when least expected, though in rare instances the first hæmorrhage may be so profuse as to prove fatal. In other cases the bleeding does not cease entirely, there being a continuous discharge of small quantities of a blood-stained fluid, which eventually so weakens the woman that a comparatively slight acute hæmorrhage may be sufficient to cause death. In a certain proportion of cases, particularly when the insertion is marginal, the bleeding does not appear until the time of labor, when it may vary from a slight, blood-stained discharge to a profuse or even fatal hæmorrhage. As a rule, it is less copious in this than in the other varieties.

The mode of production of the hæmorrhage is readily understood when one recalls the changes which take place in the later weeks of pregnancy and at the time of labor. When the placenta is inserted centrally it is evident that as the formation of the lower uterine segment and the dilatation of the



internal os progress its attachments must inevitably be torn through, the rupture being necessarily followed by hæmorrhage from the intervillous spaces and from the vessels of the decidua. Moreover, as the lower uterine segment becomes developed, it is impossible for the ovum to follow its retraction, and consequently the connection between it and the placenta must of necessity be more or less completely severed and hæmorrhage result. At the same time, the bleeding is favored by the fact that it is impossible for the stretched fibers of the lower uterine segment to compress the torn vessels, as is the case when the placenta becomes separated during the third stage of a normal labor. Furthermore, when the placenta has developed in the capsularis, it is apparent the latter is deprived of all support where it bridges over the region of the internal os, and consequently a slight trauma would open up the intervillous space.

As the placenta prævia occupies the lower portion of the uterus, it interferes with the accommodation of the fœtal head, and consequently abnormal presentations are unusually frequent, Müller having noted 272 transverse and 107 breech presentations in 1,148 cases.

In normal labor all danger is ordinarily past with the completion of the second stage; but in placenta prævia, as a result of abnormal adhesions or an excessively large area of attachment, the process of separation is sometimes interfered with, while in other cases there is a pronounced tendency to atony of the uterus. As a result, profuse hæmorrhage frequently occurs after the birth of the child, and exceptionally continues even after the manual removal of the placenta.

**Diagnosis.**—Placenta prævia should always be suspected in patients suffering from uterine hæmorrhage in the second half of pregnancy, and its possibility should be borne in mind until a careful examination has revealed some other satisfactory explanation for its origin. In the great majority of cases the cervix is softer and more succulent than usual, and its canal is more or less patulous, so that but little difficulty is experienced in carrying the finger through the internal os and feeling the characteristic sponge-like placental tissue, or at least making out a soggy, thick substance lying between the finger and the presenting part. When, however, the cervix is not patulous it should be dilated, under anæsthesia if necessary, sufficiently to permit the introduction of the finger, which is then passed through the internal os and swept around the adjacent portion of the lower uterine segment, when the presence or absence of the abnormality can be positively determined. It is true that such a procedure occasionally results in the induction of premature labor; but the risk is nevertheless quite justifiable, since we possess no other means of arriving at a definite diagnosis, which should be made at any cost on account of the very serious menace which the existence of the condition offers to the life of the patient.

**Prognosis.**—The prognosis is always serious. According to Müller, under expectant treatment the maternal mortality varied from 36 to 40 per cent., while for the children it was about 66 per cent., one half of those which are born alive perishing within the first ten days following delivery. The danger to the mother arises primarily from hæmorrhage, which is usually the direct result of the condition, though frequently it may be in-

creased by deep cervical tears resulting from too hasty artificial dilatation, or to the extraction of the child through an imperfectly dilated cervix. Moreover, such patients are particularly prone to puerperal infection, which is favored by the presence of the thrombosed sinuses in the lower uterine segment.

The foetal mortality is due in great part to the fact that many of the children are born some weeks or months prematurely. In many instances they perish from asphyxiation, the result of placental hæmorrhage, while occasionally they succumb during attempts at extraction through an imperfectly dilated cervix.

Nowadays the maternal mortality depends upon the variety of the placenta prævia, the method of delivery, and the condition of the patient when first seen. Thus, in 178 cases reported by Hofmeier, Behm, and Lomer, and treated by 11 different obstetricians by Braxton Hicks's method of combined version, the maternal mortality was 4.5 per cent., whereas 93 cases in the hands of the three operators above mentioned showed a mortality of only 1 per cent. Koblanck reports a death-rate of 3.8 per cent. in 467 cases treated in the Frauenklinik in Berlin, Jellett one of 3.69 per cent. in 138 cases treated at the Rotunda in Dublin, and Pinard one of 2.18 per cent. in 183 cases treated in his service. Of the 20 deaths reported by Bürger and Graf in 1905, 7 were due primarily to hæmorrhage, 4 to lacerations of the cervix and lower uterine segment, 1 to pulmonary embolism, and 8 to infection. According to their figures the prognosis is from 3 to 8 times more serious in central placenta prævia than in the other varieties. Furthermore, the mortality depends upon the condition of the patient when first seen, it being evident that women who have suffered from profuse and repeated bleeding have far less chance of recovery than those who come under observation after the first slight hæmorrhage.

Unfortunately, the foetal mortality has shown comparatively little decrease in recent years, Küstner, Bürger and Graf, and Strassmann giving percentages of 35, 55, and 61.22 respectively. A very great improvement in this respect is hardly to be anticipated on account of the large number of premature children with which one has to deal.

**Treatment.**—On account of the danger of profuse and unexpected hæmorrhage, pregnancy or labor, as the case may be, should be terminated in the most conservative manner as soon as possible after a placenta prævia has



FIG. 655.—FÆTUS PARTIALLY EXTRACTED FROM A PATIENT DYING OF PLACENTA PRÆVIA, SHOWING HOW IT ACTS AS A TAMPON (Leopold).



been positively diagnosed. There is no single method of treatment applicable to all classes, and the obstetrician who understands how to differentiate his cases will obtain the best results.

If the diagnosis is made during pregnancy, the cervix should be dilated sufficiently to permit the introduction of two fingers. This having been attained, further treatment will depend upon whether the child is viable or not. In the former case almost ideal results are obtained by the introduction of a Champetier de Ribes balloon after rupture of the membranes or perforation of the placenta, according as one has to deal with a partial or central insertion, dilatation being hastened by attaching a 2-pound weight to the end of the tube by a string and suspending it over the foot of the bed. After the expulsion of the bag the child should be delivered by version and extraction. On the other hand, if the child is not viable, equally good maternal results are more readily obtained by bringing down a foot by Braxton Hicks's manœuvre and using the breech of the child as a tampon to control further bleeding. If the hæmorrhage ceases after the foot has been brought down, the expulsion of the child may be left to Nature; but if the oozing continues, gentle traction should be made upon the leg so as to compress the placenta with the child's buttocks. Whichever method is employed, extraction should not be attempted until the cervix is completely dilated, or at least sufficiently so as to permit the ready passage of the head. Too great haste is liable to cause deep cervical tears, giving rise to profuse hæmorrhage and requiring the application of sutures, while in other instances serious difficulty may be encountered in delivering the child.

Generally speaking, better results will be obtained in private practice by the employment of Braxton Hicks's bipolar version, no matter what may be the condition of the child, for the reason that the average practitioner will rarely be equipped with a suitable balloon and the necessary paraphernalia for its introduction. In hospital practice, however, its employment has undoubtedly aided materially in diminishing the foetal mortality.

In very exceptional instances in primiparous women the cervix may be so rigid that it is impossible to dilate it sufficiently to permit the employment of either of the above-mentioned procedures. Under such circumstances, in the hands of an expert, abdominal or vaginal Cæsarean section may be indicated, but in general practice a tight cervical and vaginal pack of sterilized gauze bandage should be applied. After remaining in place for a few hours this will usually bring about sufficient dilatation to permit the employment of whatever manœuvres may be deemed necessary. The use of the pack, however, should be restricted as far as possible, and should be regarded merely as a temporary expedient, partly because it may give rise to a false sense of security, but particularly on account of the danger of infection.

At the time of labor, the treatment depends upon the degree of dilatation and the condition of the patient. If the cervix is obliterated, immediate delivery by version or forceps is indicated. On the other hand, if the dilatation is only partial, the hæmorrhage slight, and the placenta inserted marginally, good results frequently follow rupture of the membranes, since

the placenta is then able to follow the retracting uterine wall. In all other cases, provided the child is alive, I prefer to complete the dilatation by means of a large Champetier de Ribes balloon. For this purpose it should be introduced into the amniotic cavity after rupturing the membranes or perforating the placenta, as the case may be, and gentle traction exerted by the hand or a weight attached to the end of the tube. After dilatation has been completed, delivery is usually best effected by version and extraction. If, however, the child is dead, or a balloon is not available, equally satisfactory results may be obtained by Braxton Hicks's method of bipolar version, provided extraction is not attempted until the cervix is fully dilated.

The practitioner is earnestly warned against the employment of rapid manual or instrumental dilatation. In this class of cases the cervix is particularly prone to laceration, and no matter how gradually and carefully the dilatation may be effected deep tears frequently result. These may extend far out into the base of the broad ligament or up into the lower uterine segment, and occasionally entirely through the uterine wall. I recall one of my own cases in which death resulted from a large broad ligament hæmatoma following a tear through the lower uterine segment, which I thought had been satisfactorily repaired, as well as several consultation cases in which laparotomy and amputation of the uterus were necessary to check hæmorrhage following complete uterine rupture.

As already indicated, all danger has not passed with the delivery of the child, and great care should be exercised in the conduct of the third stage of labor. If there is no hæmorrhage, expression should not be attempted until the placenta has been expelled into the vagina; but if bleeding is at all profuse, Credé's method of expression should be immediately resorted to, and, if not effective, the placenta should be removed manually. Occasionally the loss of blood continues after the completion of the third stage. In such cases the cervix should be inspected, and immediately repaired if lacerated; but if no lesions are present, an intra-uterine pack should be introduced, so as to exert compression upon the flabby lower uterine segment.

Whenever the hæmorrhage has been profuse, and the patient presents the subjective symptoms of an acute anæmia, it becomes necessary to resort to the constitutional measures outlined under the treatment of post-partum hæmorrhage. Occasionally, when the patient is markedly exsanguinated when first seen, but is losing little or no blood at the time, it is better to devote one's attention to improving her general condition rather than to attempt immediate delivery.

In view of the danger to the mother, but particularly because many children are sacrificed by extraction through an imperfectly dilated cervix, after version by Braxton Hicks's method, Tait, Palmer, Dudley, and others recommended the performance of Cæsarean section, provided the child is viable and the patient in good condition. Ten years later, in 1908, Krönig and Sellheim stated that 8 to 10 per cent. of all placenta prævia patients die from hæmorrhage, and held that our methods of treatment were in urgent need of improvement. Furthermore, as they believed that



any method associated with natural or artificial dilatation of the lower uterine segment still further accentuated the danger, they advocated that all cases of partial or central prævia should be treated by classical or extra-peritoneal Cæsarean section, after which the lower uterine segment should be tightly packed with iodoform gauze. Their proposal was accepted by many operators, but called forth severe criticism on the part of more conservative obstetricians and has given rise to a voluminous literature.

When we remember that Jellett, and Pinard in 1910, reported a maternal mortality from all causes of 3.69 and 2.18 per cent., respectively, it is apparent that our German confrères have either greatly over-estimated the dangers of the condition, or had treated their patients badly prior to the employment of radical measures. This being the case, it seems doubtful whether Cæsarean section will come into very general use, particularly as it is applicable only to hospital patients, or to the rich, who can be surrounded by every convenience and safeguard. If such treatment were generally adopted among the poorer classes in their own homes, the death-rate, I am sure, would be much greater than that obtained by the usual methods. Moreover, as has been said, the fetal mortality in any case is not susceptible of any material reduction, for the reason that the pregnancy is generally terminated before term, when the chances of extra-uterine life are relatively unfavorable. Ehrenfest and Holmes, after carefully considering the subject, have arrived at the same conclusion. Nevertheless, I am prepared to admit that Cæsarean section may occasionally be the operation of choice, as, for instance, when a primipara with a rigid cervix and a living child is overtaken by profuse hæmorrhage. Bumm, in 1905, strongly recommended vaginal Cæsarean section in appropriate cases, and since then many operators have employed it. That its results have not been as satisfactory as were anticipated is shown by the fact that his assistant, Jolly, strongly deprecated its employment in 1911.

The mode of production and significance of slight ante-partum hæmorrhage, which sometimes follows intra-uterine *rupture of the cord* or the tearing of the vessels of the velamentously inserted umbilical cord, have already been considered in Chapter XXVIII.

### POST-PARTUM HÆMORRHAGE

With the exception of the very rare cases incident to inversion of the uterus, a serious bleeding following the birth of the child is usually due to one of three causes. Of these the most common is retention of the partially separated placenta or of individual cotyledons; less often it is due to deep tears involving the tissues of the birth canal, and in very rare instances to defective functioning of the uterine musculature—atony.

**Ætiology.**—As long as the placenta remains firmly attached to the uterine wall the possibility of hæmorrhage is slight, but when it has become partially separated, the normal action of the uterine musculature is interfered with. As a result the torn vessels at the partially denuded placental site are not constricted, and more or less profuse hæmorrhage occurs. Imperfect separation of the placenta can usually be attributed to



improper management of the third stage of labor, particularly the too early and energetic employment of Credé's manœuvre. Exceptionally, it may result from an abnormally intimate attachment of the placenta, due to a decidual endometritis or some other morbid condition. The retention of isolated cotyledons or of a small succenturiate lobe interferes with the normal contraction and retraction of the uterus in precisely the same manner as the partially separated placenta.

The part played by deep tears of the generative tract is perfectly obvious, and will be considered in detail in the following chapter.

In very rare instances serious hæmorrhage may result from rupture of large varicose veins, of an aneurysm of the uterine artery, or the disturbance of areas of thrombosis in the cervix.

Formerly, *atony* of the puerperal uterus was considered the most frequent cause of post-partum hæmorrhage, but more careful observation has shown that such a condition is seldom primary; for, with the exception of the rare instances in which it follows excessive distention of the uterus incident to twin pregnancy or hydramnios, serious abnormalities in the contractile function of the uterine musculature are usually associated with some mechanical cause, such as retention of portions of the placenta, the presence of myomata, or in rare cases the existence of adhesions between the uterus and the surrounding organs. Occasionally atony may be associated with degeneration of the muscle fibers resulting from an abnormal invasion of foetal elements, as described by Kworostansky, Martin, and others. It is probable, however, that Veit goes too far in denying *in toto* the possibility of a primary atony, although Hofstätter did not observe a single example in the 13 fatal cases of post-partum hæmorrhage occurring in a series of 32,180 labors in Rosthorn's clinic.

The rare cases of hæmorrhage following *paralysis at the placental site*, in which the rest of the organ remains firmly contracted, as in the cases reported by Chiari, Braun and Spaeth, Olshausen, and others, point to the possibility of a partial atony; while the occasional instances in which patients bleed profusely after each labor without demonstrable cause likewise afford corroborative evidence. At the same time the possible existence of hæmophilia should always be borne in mind in such women, as in a case reported by Wehle.

**Clinical History.**—Severe hæmorrhage is observed once in every few hundred labors, but with proper treatment a fatal issue should occur only once in 2,000 or 2,500 patients. Excessive bleeding may supervene either during or after the third stage of labor. In the first class of cases, as a rule, it is the result of tears or of partial separation of the placenta. Fortunately, hæmorrhage dependent upon the latter cause is usually not serious, for the reason that the condition is only transitory, complete separation occurring spontaneously as the result of uterine contraction, when satisfactory retraction checks the loss of blood. Exceptionally the bleeding may persist even after the placenta has become completely separated and lies free in the uterine cavity. In such cases it is due either to tears or to imperfect functioning of the uterus.

Generally speaking, partial separation occurring during the course of



placental expulsion by the Schultze mechanism is not accompanied by external hæmorrhage until the placenta escapes from the vulva, when the large amount of blood collected behind it is suddenly discharged. In Duncan's mechanism, on the other hand, the loss of blood continues throughout the entire placental period.

A hæmorrhage which persists after the extrusion of the placenta may be due to tears, retention of placental remnants, or to atony. In the first there is a steady flow of bright-red blood, which begins immediately after the delivery of the child. When due to retained placental tissue, the blood escapes in gushes, which are apt to be synchronous with the uterine contractions, and is frequently in large clots; whereas in cases due to primary atony there is a continuous flow of blood, which may be so abundant as to cause death within a very few minutes. In rare instances the hæmorrhage may be *concealed*, several liters of blood sometimes accumulating in the uterine cavity.

The amount of blood lost during a post-partum hæmorrhage may vary from 500 to 3,500 cubic centimeters, the latter extreme, however, being invariably incompatible with life. Generally speaking, the woman in labor can bear with comparative impunity the loss of an amount of blood which would seriously endanger the life of a well-developed man. This is attributed by Zuntz to the fact that a marked increase in the amount of blood occurs during pregnancy. He estimates that it constitutes 5.3 per cent. of the body weight before conception, and increases to 8.4 per cent. at the end of pregnancy. On the other hand, Fries holds that there is no such increase. However this may be, the effect of hæmorrhage will depend more upon the general condition of the patient than upon the actual quantity lost. Thus, a woman who is already exhausted by a prolonged labor or weakened by antecedent disease may succumb after a loss of from 1,000 to 1,500 cubic centimeters, which others bear with impunity. As a rule, the loss of a small amount of blood is not attended by serious symptoms; but when the hæmorrhage is profuse the pulse becomes rapid and compressible, the face becomes pallid and assumes a drawn appearance, while at the same time the woman may complain of disturbed vision, chilliness, and shortness of breath. In extreme cases symptoms of air hunger appear, and the patient usually passes into unconsciousness before the fatal termination.

**Diagnosis.**—The diagnosis offers no difficulty, except in the rare instances in which the hæmorrhage has taken place into the uterine cavity and does not appear externally. It must, however, be distinctly stated that concealed hæmorrhage should never occur if the condition of the uterus is conscientiously watched, although, if routine precautions are neglected, the first indication of the condition may be afforded by the pale and haggard appearance of the patient. On examination the pulse-rate will be found greatly accelerated, the uterus markedly increased in size, and presenting a doughy consistence, instead of the characteristic firm, hard sensation offered by the normal puerperal organ. Pressure upon it is followed by a copious flow of blood from the vagina.

As the decision concerning the proper treatment of the patient generally depends upon the recognition of the source of the hæmorrhage, a differential



diagnosis is of the utmost importance. Generally speaking, if the bleeding commences immediately after the birth of the child, it is due either to tears of the genital tract or to partial separation of the placenta. In the latter case it usually ceases temporarily after energetic kneading of the uterus, but recurs as soon as it is allowed to relax. If such manipulations prove of no avail, it is probable that the hæmorrhage comes from a tear, although this is not a universal rule, since in a certain number of instances the loss of blood will continue until the placenta is expressed by Credé's method or is removed manually.

Again, a hæmorrhage persisting after the uterus has been emptied, while abdominal palpation shows that the organ itself is firmly contracted, suggests an extensive tear of the birth canal, which should be sought for, and closed with sutures when found. In order to accomplish this, the patient having been brought to the edge of the bed, the external genitalia are carefully inspected. If the perineum is intact, the cervix should be forced down toward the vulva by pressure upon the fundus, and if this fails to bring it into view, it should be examined by the fingers in the vagina. If a cervical lesion cannot be detected, the vaginal walls should be spread apart by means of a speculum and thoroughly inspected. A hæmorrhage which does not come on until ten or fifteen minutes after the birth of the child can hardly be due to this cause.

On the other hand, if the uterus does not contract and retract firmly after the expulsion of the placenta, or if it remains so only so long as kneading is kept up, the cause of the hæmorrhage must be sought for either in the retention of a placental cotyledon or in atony. Certainty with regard to the former point is usually obtained by careful inspection of the after-birth, a large defect upon its maternal surface indicating the retention of a cotyledon, while a more or less circular defect in the membranes a short distance from the placental margin shows that a succenturiate lobe has been left behind. At the same time one should be careful not to confound mere fissures with defects due to loss of tissue. The diagnosis of primary atony should be made only after every other explanation has been excluded.

**Treatment.**—With proper management, hæmorrhage during and immediately following the third stage of labor should be extremely rare. The most important prophylactic measures consist in watching the condition of the uterus after the birth of the child, and not resorting to Credé's manoeuvre until the rising up of the fundus indicates that the placenta has become completely detached. Premature attempts at expression are a frequent cause of imperfect separation. Again, owing to the tendency toward relaxation following the birth of twins, as well as in hydramnios, concealed hæmorrhage, and placenta prævia, the condition of the uterus in such cases should be most carefully watched for the few minutes immediately following the birth of the child, and energetic kneading through the abdominal walls promptly resorted to upon the first sign of failing contraction.

The placenta should be carefully examined immediately after its expulsion, for the purpose of ascertaining whether it is intact. If it shows any serious defect, immediate preparations should be made for the removal of the retained portion in case symptoms supervene.



In the presence of actual hæmorrhage, the treatment varies according as the placenta is still within the uterus or has already been expelled. In the former case the uterus should at once be grasped through the abdominal wall and firmly kneaded. If firm contractions come on, all is well, but if the hæmorrhage continues and the uterus relaxes as soon as the kneading is stopped, the placenta should be expressed by Credé's method; and if this cannot be accomplished and the patient's condition is alarming, it should be removed manually, when the directions given in Chapter XXIV should be most conscientiously followed.

If the hæmorrhage does not cease after the delivery of the placenta, the cause should be ascertained and suitable treatment instituted. Tears should be located and their edges brought together by sutures. On the other hand, if the hæmorrhage is the result of the retention of placental tissue, the gloved and disinfected hand should be carried up into the uterus in order to seek for and remove the retained cotyledon. In such circumstances the hand acts as a most efficient irritator, causing the uterus to contract energetically. After separating the retained portion of placenta, the hand should not be withdrawn at once, but should be allowed to recede gradually as it is forced down by the contraction of the fundus.

If the hæmorrhage is due to atony the uterus should be vigorously kneaded, and 60 minims of the fluid extract of ergot or of ergotol administered hypodermically. After careful disinfection of the skin, the needle should be plunged deep down into the tissues of the thigh, at right angles to the surface, since in this way the chances of abscess formation are greatly diminished. The experiments of Kurdinowsky indicate that adrenalin has an even more potent effect, and the clinical observations of Neu show that the injection of 0.0001 gram of suprarenin directly into the uterine musculature brings about intense contractions. Furthermore, Foges and Hofstätter state that the hypodermic employment of 2 cubic centimeters of "pituitrin" is likewise more efficient than ergot. I have had no personal experience with the use of either drug.

If these measures are not attended with the desired result a very hot intra-uterine douche of several liters of sterile salt solution should be given. This usually acts as a most efficient hæmostatic, effectively irritating the uterus and causing it to contract forcibly and permanently.

If the hæmorrhage persists in spite of the douche, our only hope of controlling it is by packing the uterus tightly with sterile gauze, which should be introduced according to the directions given in Chapter XXIV (see Fig. 441). Before resorting to the use of the pack it is always advisable to palpate the interior of the uterus, as occasionally a portion of the placenta may have been retained, even though immediately after expulsion the organ may have apparently been entire.

Should the loss of blood continue after the employment of these measures the aorta should be compressed by means of a stout rubber tube tied about the patient's waist, as recommended by Momburg. This emergency measure has been extensively employed, and its value was critically considered by Guéniot in 1911.

Formerly it was customary to recommend the introduction into the

uterus of ice or solutions containing vinegar, the perchloride of iron, or other astringent substances. Their employment, however, is not advisable, since ice and ordinary vinegar are never sterile, while the iron solution accomplishes its purpose by the formation of dense coagula, which are later separated from the uterus by suppurative processes. Above all, none of them act as promptly or efficiently as the pack, the employment of which, although comparatively rarely indicated, in exceptional cases offers the only reliable means of coping with the condition. For this reason the obstetrician should always carry in his bag the materials necessary for it, as they cannot usually be obtained promptly in an emergency.

Too great stress cannot be laid upon the importance of observing the most rigorous aseptic technique in every intra-uterine manipulation undertaken for the purpose of checking post-partum hæmorrhage. The natural tendency of the physician is to forget all other risks in his attempts to check the bleeding promptly. Such neglect, however, is frequently attended by most serious consequences, the patient being saved from death from hæmorrhage merely to perish of infection a few days later. For this reason, therefore, the obstetrician will usually best subserve the interests of his patient by taking the time necessary for carefully disinfecting his hands before beginning any manipulations. In fact, the only exception is offered by the very rare cases of atonic hæmorrhage in which it appears probable that a delay even of a few minutes means inevitable death.

After the actual hæmorrhage has been checked, attention must be directed to the general condition of the patient. When the shock is not profound and the pulse not particularly rapid, elevation of the foot of the bed and the application of hot bottles or bricks to the extremities will be all that is needed. In more severe cases, the administration of 1/30 grain of strychnine hypodermically, 3 doses being given in prompt succession, if necessary, is attended by excellent results, which may be supplemented by hypodermic injections of whisky or ether. Hot rectal enemata of equal parts of black coffee and salt solution are also valuable.

When the patient is profoundly shocked, sterile normal salt solution in large quantities—500 cubic centimeters being injected under each breast, and repeated as soon as absorption has occurred—will prove the best restorative, and even more striking results may be obtained by administering it intravenously. Occasionally, when the loss of blood has been very great, these measures may be supplemented by actual transfusion by means of arterio-venous anastomosis.

## INVERSION OF THE UTERUS

This condition is a very rare, but important, cause of post-partum hæmorrhage. According to Beckmann, not a single case occurred in 250,000 labors in the St. Petersburg Lying-in Hospital, while Madden noted it only once in 190,833 deliveries in Dublin. Many obstetricians in large practice have never seen a case, or have met with only a few examples of the condition. On the other hand, it is much more frequently noted in the practice of ignorant midwives. The historical and statistical aspects of the



subject are fully dealt with in the articles of Beckmann, Browne, Holmes, and Vogel.

Now and again the fundus of the uterus becomes inverted and comes into close contact with or may protrude through the external os; while in rare instances the entire organ appears outside of the vulva, the condition being respectively designated as *incomplete* and *complete inversion*, and *prolapse of the inverted uterus* (Fig. 656). In not a few cases the placenta remains attached to the inverted organ.

**Ætiology.**—For the production of the accident three factors are necessary: marked laxity or thinness of the uterine walls, particularly at the



FIG. 656.—COMPLETE INVERSION OF UTERUS (Bumm).

placental site, pressure from above or traction on the cord or placenta, and a patulous cervical canal. Its occurrence is also favored by a fundal insertion of the placenta. Inversion may occur spontaneously as the result of the intra-abdominal pressure or from the mere weight of the intestines, but in most cases it is attributable to violence resulting from the too vigorous employment of Credé's manœuvre or to traction upon the cord. In one of the cases which I saw in consultation it followed the manual removal of the placenta, while in two others it was due to too vigorous expression. Occasionally, inversion may recur in the same patient, Fritsch having observed it in three successive pregnancies.

Beckmann, who has carefully analyzed 100 cases reported in the litera-

ture, believes that in the majority of instances the accident occurs spontaneously, while Vogel, in a similar review, holds that most cases are due to violence. His contention appears to be confirmed by Beckmann's statistics, as only 3 of the 100 cases occurred in hospital practice. Indeed, it is highly probable that the accident is excessively rare when labor is properly conducted, but that it occurs more frequently under the unfavorable conditions existing in private practice, particularly as conducted by midwives.

The complication usually follows a full-term labor, although a number of cases are recorded in which it was noted after abortion. It is also an interesting fact that more than 50 per cent. of the cases recorded by both Beckmann and Vogel were in primiparous women.

**Symptoms.**—As a rule, inversion of the uterus is promptly followed by alarming symptoms, the patient presenting marked evidences of shock, with a rapid pulse and a tendency to syncope. In other cases convulsions occur and profuse hæmorrhage is frequently noted. On the other hand, the symptoms are sometimes very slight, and the condition may continue for several days without causing any serious annoyance to the patient.

In rare instances the cervix may so retract about the completely inverted uterus that strangulation occurs, followed by gangrene. In other cases this does not take place, but the condition becomes chronic, necessitating operative procedures later.

**Prognosis.**—If the condition is detected promptly, and the uterus replaced immediately, the prognosis is fair, Beckmann reporting a mortality of 14 per cent. On the other hand, if strangulation or gangrene occur, the outlook is ominous.

**Treatment.**—In very recent cases reposition can usually be effected without difficulty by pressure exerted by several fingers in the vagina, it being important to remember that the force should be directed upward in the axis of the superior strait. Neglect of this precaution undoubtedly accounts for a certain number of failures. As the procedure is generally painful, anæsthesia should be employed.

If the placenta is still attached to the uterus, it is generally advisable to defer its separation until reposition has been effected, because, the contractile function of the inverted uterus being in abeyance, there is always the risk of profuse hæmorrhage. On the other hand, if the patient is not seen until several days after labor, the cervix may be so contracted that manual reposition cannot be accomplished, and operative procedures will become necessary. Full particulars concerning these will be found in the current works on gynaecology.

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## CHAPTER XLI

### INJURIES TO THE BIRTH CANAL

#### INJURIES TO THE VULVAL OUTLET

In the chapter upon the Conduct of Normal Labor reference was made to the frequency of perineal lacerations, and emphasis was laid upon the necessity for repairing them immediately after the birth of the child.

More rarely tears occur about the anterior portion of the vulva. In spontaneous labor these seldom amount to more than slight abrasions upon the inner surfaces of the labia minora, but in forceps deliveries, especially when the handles have been unduly elevated, serious lesions may follow the compression of the tissues between the pubic arch and the blades of the instrument. Now and again the labia minora are completely severed and torn loose from their connections, or deep tears occur on either side of the urethra implicating the vessels supplying the clitoris and giving rise to profuse hæmorrhage; while following pubiotomy, such tears may communicate with the pubic wound.

#### INJURIES TO THE VAGINA

With the exception of the most superficial varieties, which are limited to the mucous membrane of the fourchette, all perineal lacerations are accompanied by more or less injury to the lower portion of the vagina. Such tears rarely occur in the median line, but extend a variable distance up one or both vaginal sulci, being almost always sufficiently deep to involve some fibers of the levator ani muscle. Bilateral lacerations of this variety are usually unequal in length and are separated from one another by a tongue-shaped portion of mucosa which represents the lower end of the posterior column of the vagina (Fig. 315).

These injuries should always be looked for, and their repair should form a part of every operation for the restoration of a lacerated perineum. If this precaution is neglected and the external wound alone is sutured, the patient will eventually present symptoms due to *relaxation of the vaginal outlet*, even though the perineum proper may be in perfect condition.

Isolated tears involving the middle or upper third of the vagina, and unassociated with lacerations of the perineum or cervix, are very rarely observed. They are usually longitudinal, and result from injuries sustained during a forceps operation, though now and again they follow spontaneous delivery. They frequently extend deeply into the underlying tissues, and may give rise to a copious hæmorrhage, which, however, is readily con-



trolled by a few sutures. Their presence is readily overlooked, inasmuch as they can be recognized only after the vaginal walls have been spread apart by means of a speculum.

More important are the *injuries to the levator ani muscles*, which, as they are not associated with tears through the vaginal mucosa, usually escape immediate detection. As the result of overdistention of the birth canal, there may occur a submucous separation of certain fibers of the muscle, or at least so great a diminution in its tonicity that it can no longer properly fulfil its function as the pelvic diaphragm. In these cases the patient sooner or later suffers just as severely from symptoms of relaxation as if a deeply lacerated perineum had been left unrepaired. Although the accident can sometimes be avoided by an intelligent use of forceps when the second stage of labor is unduly prolonged, indications for prophylactic measures are not always at hand, since it frequently follows spontaneous and rapid delivery.

Lesions of the upper third of the vagina are extremely uncommon unless they represent the extension of deep cervical tears into the fornix. In very rare instances, however, the cervix may be entirely or partially torn loose from its vaginal attachment, rupture in other cases occurring in either the anterior, posterior, or lateral fornix. Hugenberger, in 1875, collected 40 cases of this accident from the literature, and designated it as *colpaporrhesis*; while Kaufmann, in 1901, estimated that something more than 100 cases have been recorded altogether.

The accident is somewhat analogous to rupture of the lower uterine segment, and follows energetic efforts on the part of the uterus to overcome some obstacle to the passage of the child. As a result of the retraction of Bandl's ring, so great a strain may be exerted upon the cervix that it is torn loose from its vaginal attachment. It is commonly taught that *colpaporrhesis* is possible only in those cases in which the lips of the cervix are not compressed between the presenting part and the pelvic wall, but are free to follow the retracting uterus. It sometimes occurs spontaneously, but more frequently follows ill-chosen operative procedures.

The symptoms are identical with those following rupture of the uterus, and will be considered under that heading. Immediately following the rupture, the child may escape into the peritoneal cavity, after which the intestines may protrude into the vaginal canal, as in a case reported by Ross.

The diagnosis is made solely by the sense of touch, as the clinical symptoms do not differ from those following rupture of the uterus. The prognosis is extremely unfavorable, 60 to 75 per cent. of the cases reported in the literature having ended fatally.

Most authorities recommend treating the condition by means of a vaginal pack, a procedure which probably explains in part the high mortality. I, however, agree with Schick that laparotomy offers the best chance for successfully coping with this emergency, since in this way one can obtain an accurate idea of the extent of the injury, when the torn surfaces may be united by sutures, or, failing that, the uterus may be removed.

### LESIONS OF THE CERVIX

Slight degrees of cervical laceration must be regarded as an inevitable accompaniment of childbirth. Such tears, however, heal rapidly and rarely give rise to symptoms. In healing they cause a material change in the shape of the external os, and thereby afford us a means of determining whether a woman has borne children or not.

In other cases the tears are deeper, implicating one or both sides of the cervix and extending up to or beyond the vaginal junction. In rarer instances the laceration may extend across the vaginal fornix or into the lower uterine segment, and occasionally open up the base of the broad ligament. Such extensive lesions frequently involve vessels of considerable size, and are usually associated with profuse hæmorrhage.

Deep cervical tears occasionally occur during the course of spontaneous labor, and under such circumstances their genesis is not always readily explainable. More usually, however, they follow rapid manual or instrumental dilatation, especially in eclampsia, placenta prævia, or in women suffering from general œdema. Moreover, they are apt to result from attempts at delivery through an imperfectly dilated cervix, no matter whether forceps or version be employed.

Occasionally, even in spontaneous labors, the anterior lip of the cervix may be caught between the head and the symphysis pubis and be compressed until it undergoes necrotic changes and separation occurs. In still rarer instances the entire vaginal portion may be torn loose from the rest of the cervix. According to Boudreau, this so-called *circular detachment of the cervix* usually occurs in elderly primiparæ when the pains are strong and a serious obstacle to delivery is offered by an imperfectly dilated os externum.

**Symptoms.**—In all lesions involving the cervix there is usually no escape of blood until after the birth of the child, when the hæmorrhage may be profuse. In many cases, however, the bleeding is so slight that the condition would pass unrecognized were it not detected upon vaginal examination. When one lip of the vaginal portion of the cervix is torn off, there is usually very little hæmorrhage, for the reason that the tissues have been so compressed before the occurrence of the accident that the vessels have undergone thrombosis; likewise, circular detachment of the cervix is often not followed by bleeding.

Slight cervical tears heal spontaneously, provided the patient remains uninfected; but extensive lacerations afford to any pathogenic micro-organisms which may be present a ready port of entry into the lymphatics at the base of the broad ligament.

**Diagnosis.**—A deep cervical tear should always be suspected in cases of profuse hæmorrhage coming on during the third stage of labor, if the hand applied over the lower abdomen can feel that the uterus is firmly contracted. For a positive diagnosis, however, a vaginal examination is necessary, while the extent of the injury can be fully appreciated only after drawing the cervix down to the vulva and subjecting it to direct inspection.



trolled by a few sutures. The cervix should be inspected at force, even if there be no bleeding; since in this way tears will be discovered, which should be treated by suture.

More important are the lacerations of the perineum. Annular detachment of the perineum should be diagnosed whenever an irregular opening is cast off before or after the birth. Lacerations accompanied by hæmorrhage should be treated by the introduction of a few sutures readily check-  
 escape immediate detection. In such cases, there may occur a subcutaneous collection, or at least so great a distension of the canal, that it properly fulfil its function. The patient sooner or later suffers as if a deeply lacerated perineum. An accident can sometimes be avoided in the second stage of labor is un-  
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Lesions of the upper part of the vagina, unless they represent the external opening. In very rare instances, however, the vagina is torn loose from its vaginal opening, in either the anterior, posterior, or lateral. I collected 40 cases of this accident, which I call *colpaporrhaxis*; while Kammacher reports more than 100 cases have been observed.

The accident is somewhat rare, and follows energetic efforts to come some obstacle to the passage of Bandl's ring, so great that the vagina is torn loose from its vaginal opening. *colpaporrhaxis* is possible only when the cervix are not compressed between the pelvic walls, are free to follow the retraction of the uterus, but more frequently follow the rupture of the uterus.

The symptoms are identical with those of the rupture of the uterus, and will be considered below. Following the rupture, the child is born, in which the intestines may protrude, as reported by Ross.

The diagnosis is made solely from the symptoms do not differ from those of the rupture of the uterus. The prognosis is extremely unfavorable, as reported in the literature having a high mortality.

Most authorities recommend a vaginal pack, a procedure which is of little value. I, however, agree with those who think that a chance for successfully coping with the accident. One can obtain an accurate idea of the extent of the laceration, and the surfaces may be united by sutures, if removed.



FIG. 1. TO REPAIR (Bumma).

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The treatment of cervical tears associated with hæmorrhage varies with the extent of the lesion. When the laceration is limited to the cervix, or even when it extends well into the vaginal fornix, most satisfactory results are obtained by the introduction of sutures after bringing the cervix into view at the vulva. This is effected by having an assistant make firm downward pressure upon the uterus, while at the same time the operator exerts strong traction by means of a bullet forceps inserted into either lip of the cervix, the vaginal walls, if necessary, being held apart by means of suitable retractors (Fig. 657). As the hæmorrhage usually comes from the upper angle of the wound, it is advisable to apply the first suture in that situation, since if the suturing is begun at the free end of the tear a dead space is often left toward its upper extremity, from which subsequent hæmorrhage may occur. Chromicized catgut sutures should be employed, as they do not have to be removed. The beginner is cautioned against too great a regard for appearances and attempting to give the cervix too normal a look, inasmuch as the retraction occurring within the next few days may lead to such constriction of its lumen as to cause retention of the lochial discharge.

Many authorities recommend a tight vaginal pack in this class of cases. No doubt it will usually check the hæmorrhage and may be employed in an emergency, but it does not compare in efficiency with repair by suture. In the rare cases in which the wound extends through the broad ligament into the peritoneal cavity a tight pack may be introduced, provided there is no serious hæmorrhage; but in all other cases the only satisfactory method of dealing with the condition is by laparotomy.

The treatment of tears of the upper part of the cervix which involve the lower uterine segment will be considered in the following section:

### RUPTURE OF THE UTERUS

This accident, which is one of the most serious with which the obstetrician can be confronted, seldom occurs except in prolonged labors, though instances of spontaneous rupture during pregnancy have been recorded.

While spontaneous rupture occurs more frequently in the last months, it may be met with at any period of pregnancy. Thus 31 out of 78 cases of rupture during pregnancy collected by Baisch were observed in the first six months. In the first half of gestation the accident is usually due to laceration of the interstitial portion of the tube or in a bicornuate or infundibular uterus, or to excessive invasion of the uterine wall by foetal elements. In the last months the condition is usually associated with the presence of a tumour in the uterine wall, which yields gradually with the increasing size of the organ. Accordingly it occasionally occurs after Cæsarean section in women whose uteri had been previously perforated or otherwise injured during curettage or some other operative procedure. In other cases the accident may be attributed to faulty hypertrophy of the uterine fundal region; while Poroschin considers that it may be due to faulty development or relative absence of elastic tissue. Alexandroff,



## INJURIES TO THE BIRTH CANAL

It has been common to attribute certain cases to inherent weakness of the walls resulting from the excessive formation of connective tissue, and the removal of an adherent placenta in premature labor. In some instances, as in the two cases occurring in my practice, the cause can be discovered.

When the rupture occurs during pregnancy, the lesion is always situated in the upper portion of the uterus. This is in accordance with the conditions observed at the time of labor, when the rupture is in the lower segment, and clearly indicates that mechanical factors must be concerned. Contrary to the opinion of some, the rupture nearly always occurs in the neighborhood of the base; I have found that it was situated upon the anterior or posterior wall in 16 cases in which the location of the rupture was ascertained.

As regards diagnosis, prognosis, and treatment of this condition, the following remarks following rupture of the uterus occurring at the time of labor should be noted, however, that in a number of the cases the hemorrhage following the accident was so profuse that, from its symptoms, the condition escaping recognition and the necessity became necessary for the removal of the fetus from the maternal cavity.

In some instances, as in the cases reported by Leopold and others, the placenta remained in the uterus, while the fetus, surrounded by amnion, escaped into the peritoneal cavity, where it went on to develop as an *extra-uterine* pregnancy. Such an occurrence is almost always fatal to the fetus.

Rupture of the uterus at the time of labor occurs once in every 1,000 cases, and is a most serious complication, as it nearly always results in the death of the fetus, and frequently to that of the mother.

It is indebted to Bandl for the first clear explanation as to the mechanism, its aetiology being inseparably connected with the contraction of the lower uterine segment and the formation of the contraction ring.

Under the influence of labor pains the uterus becomes divided into two portions, separated by a circular ridge of tissue, to which the *contraction ring* is usually applied. The upper, by its contraction, expels the child, while the lower undergoes dilatation and becomes the part of the canal through which the contents of the uterus pass. On the other hand, when a serious obstacle is opposed to the passage of the child, the active portion of the uterus is stimulated to further contractions. As it contracts it likewise slowly becomes retracted, the margin—the contraction ring—eventually occupying a position higher than usual. As a result, particularly if the lips of the ring are caught between the presenting part and the superior part of the canal, a powerful traction is exerted upon the passive portion of the uterus, which becomes more and more stretched, and thinner and thinner. Finally the contraction ring separating the two portions becomes

thicker and more prominent, so that it can readily be distinguished as a transverse or oblique ridge extending across the abdomen just below or perhaps on a level with the umbilicus. The round ligaments, likewise, are subjected to an abnormal strain and remain tense even in the intervals between the uterine contractions.

As the process goes on the lower segment becomes extremely sensitive to pressure, the uterine contractions increase progressively in frequency and intensity, and cause the patient greater suffering. The pulse becomes more rapid, the patient presents a worn and haggard appearance, and the contraction ring becomes more prominent on palpation. Such a condition indicates that rupture is imminent and will occur unless delivery is promptly effected in a conservative manner.

Generally speaking, rupture is more apt to take place when one side of the lower uterine segment is subjected to greater stretching than the other. In transverse presentations this condition is most marked on the side of the uterus occupied by the head. A similar danger threatens the posterior wall when the child presents by the head and the patient has a markedly pendulous abdomen.

Excessive stretching of the lower uterine segment, with consequent danger of rupture, is favored by any factor which interferes with the birth of the child, and more particularly with the entrance of the presenting part into the pelvis. Such conditions are most frequently afforded by contracted pelves, neglected transverse presentations, hydrocephalus, excessive size of the child, and, in fact, by any obstacle to labor. The following analysis by Merz shows the ætiological factors concerned in the production of 160 cases of rupture of the uterus:

|                                              |    |
|----------------------------------------------|----|
| Contracted pelvis .....                      | 70 |
| Neglected transverse presentation.....       | 26 |
| Hydrocephalus .....                          | 18 |
| Large child or unfavorable presentation..... | 10 |
| Stenosis of birth canal.....                 | 6  |
| Trauma .....                                 | 5  |
| Pelvic tumor .....                           | 3  |
| Ascites .....                                | 1  |
| Operative procedures .....                   | 21 |

It is generally held that excessive stretching of the lower uterine segment can occur only after a prolonged second stage, but Goldner, in 1903, reported 19 instances in which rupture appeared imminent before the escape of the amniotic fluid. In these cases the condition was associated with oligohydramnios, very resistant membranes, or a rigid cervix.

It is customary to distinguish between *spontaneous* and *traumatic rupture* of the uterus. In the former the accident occurs spontaneously, while in the latter it is usually the result of ill-judged manipulations on the part of the obstetrician in a uterus whose lower segment is so thinned out and distended that the slightest violence proves too much for its resisting powers. In other cases it may result from the upward extension of cervical tears, following rapid manual or instrumental dilatation of the cervix.



Traumatic rupture occurs relatively frequently when version is attempted in neglected transverse presentations. The proper treatment of this class of cases requires the utmost nicety of judgment, as it is oftentimes extremely difficult to determine whether the lower uterine segment is so thinned out as to contra-indicate attempts at version, the operation being sometimes readily accomplished under anaesthesia in cases in which, at first sight, it had appeared impracticable; whereas, in others, in which it seemed that the necessary manipulations would be without danger, rupture followed the mere introduction of the hand. Moreover, there is a marked difference in the rapidity with which overstretching of the lower uterine segment comes about, the condition supervening very rapidly in some cases, while in others many hours of strong, second-stage pains may be necessary for its production.

Certain women seem to possess a predisposition toward rupture of the uterus, this assumption being supported by the fact that not a few cases

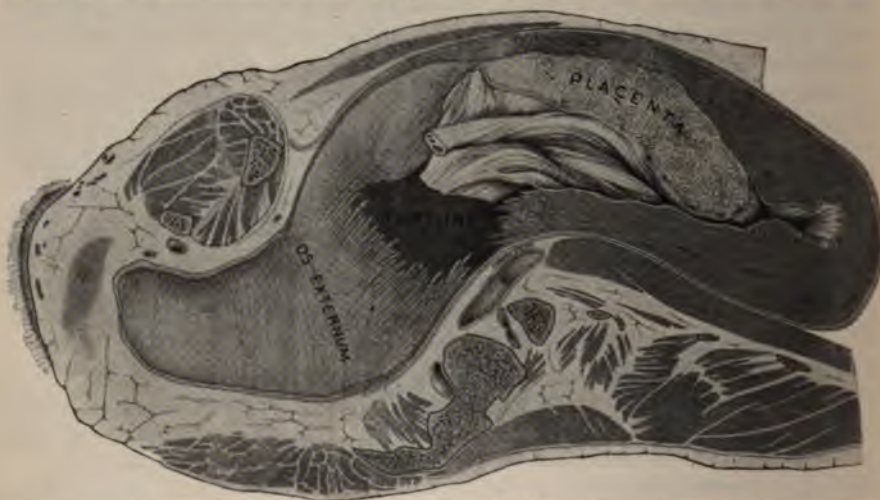


FIG. 658.—LONGITUDINAL SECTION THROUGH WOMAN DYING FROM RUPTURE OF THE UTERUS (Zweifel).

of repeated rupture appear in the literature. Thus, Mikhine found records of 13 patients, 6 of whom died as a result of a second rupture. It is quite likely that in such circumstances the second rupture occurs in tissues already weakened by the previous accident.

**Pathology.**—Rupture of the uterus occurring at the time of labor is limited almost entirely to the lower uterine segment, the rent usually pursuing an oblique direction; although when it is in the immediate vicinity of the cervix it frequently extends transversely. On the other hand, it is usually longitudinal when it occurs in the portion of the uterus adjacent to the broad ligament, and, according to Freund, when it occurs spontaneously in neglected transverse presentations.

It is customary to distinguish between *complete* and *incomplete rupture*, according as the laceration communicates directly with the abdominal cavity.

ity or is separated from it by the peritoneal covering of the uterus or broad ligament. The former is apparently the more common, Merz having collected 118 complete as against 46 incomplete ruptures. Lobenstine noted 46 and 29 cases respectively in the New York Lying-in Hospital.

Incomplete ruptures frequently extend into the broad ligament; in such circumstances the hæmorrhage often occurs less rapidly than in the complete variety, the blood slowly accumulating between the leaflets and leading to the separation of the peritoneum from the surrounding viscera, with the consequent formation of a large *subperitoneal hæmatoma*. Occasionally, an effusion of blood sufficiently copious to cause the death of the patient may be inclosed between the structures. More frequently, however, the fatal issue does not occur until rupture of the hæmatoma into the peritoneal cavity relieves the pressure which had previously, to some extent, restrained the bleeding.

Although occurring primarily in the lower uterine segment, it is not unusual for the laceration to extend further upward into the body of the uterus or downward through the cervix into the vagina. The tear itself usually presents jagged, irregular margins which are stained with blood.

Following complete rupture, the uterine contents may escape into the peritoneal cavity, while in the incomplete variety they usually remain within the uterus, but exceptionally they may come to lie beneath the serous covering of the uterus or between the leaflets of the broad ligament. When the presenting part is firmly engaged at the time of rupture, only a portion of the fœtus escapes, the rest remaining in the uterine cavity.

**Symptoms.**—The symptoms of actual rupture vary considerably. If it occurs spontaneously, or as the result of traumatism during the later months of pregnancy, the patient usually experiences sharp abdominal pain. In some cases marked symptoms of collapse immediately supervene, but in many instances the patient merely complains of malaise, grave symptoms only occurring later as the result of infection or of putrefaction of the fœtus. Thus, in one of my cases, two weeks elapsed before the appearance of alarming symptoms. In the earlier months, on the other hand, profuse hæmorrhage is the rule, and the patient rapidly succumbs to acute anæmia if not operated upon.

If the accident occurs at the time of labor, the patient, after presenting for some time the premonitory signs of the accident, suddenly, at the height of an intense uterine contraction or during an intra-uterine manipulation, complains of a sharp, shooting pain in the lower abdomen, and frequently cries out that something has given way inside of her. At the same time the lower uterine segment becomes much more sensitive to pressure. Immediately following these symptoms there is an absolute cessation of the uterine contractions, and the patient, who had previously been in intense agony, suddenly experiences marked relief. At the same time there is usually some external hæmorrhage, although in many cases it is very slight in amount.

Palpation or vaginal examination shows that the presenting part has slipped away from the superior strait and has become movable, while a hard, round body, which represents the firmly contracted uterus, can be



felt alongside of the foetus. Naturally, if the uterine contents have escaped into the abdominal cavity, the presenting part cannot be felt on vaginal examination.

As a rule, shortly after the occurrence of complete rupture, the patient presents symptoms of collapse, the pulse increases markedly in rapidity, loses tone, and takes on a filiform character, the face becomes pallid, assumes a drawn appearance, and is often covered with beads of sweat. If the hæmorrhage has been copious, she may complain of chilliness, disturbances of vision, and air hunger, and eventually pass into an unconscious state. Symptoms of collapse, however, do not always appear immediately, but are sometimes deferred for several hours after rupture, being less marked when the child remains partially within the uterus. After incomplete rupture, on the other hand, the immediate symptoms are sometimes very slight, but increase in severity as the subperitoneal hæmatoma becomes larger, while actual symptoms of collapse frequently do not appear until secondary rupture into the peritoneal cavity has taken place.

Occasionally after incomplete rupture, emphysematous crackling can be elicited in the tissues of the anterior abdominal wall, 14 cases of this character having been collected by Dischler. It is probably usually due to the invasion of the subperitoneal connective tissue by *Bacillus aerogenes capsulatus*. It is true that bacteriological proof has not been adduced in support of this statement, but the fact that the women had been in labor for many hours, and that many of the children were more or less putrefied, speaks strongly in favor of such a view.

**Diagnosis.**—In cases of spontaneous rupture during pregnancy the diagnosis is not always easy. If accompanied by profuse hæmorrhage, the profound collapse should at once lead to a provisional diagnosis, but in other cases the condition usually escapes detection until the appearance of peritonitic symptoms. Generally speaking, it may be said that a rapid pulse, slight elevation of temperature, and abdominal distention associated with very distinct palpation of the foetus, should always be regarded with grave suspicion, particularly when preceded by a history of traumatism.

On the other hand, the diagnosis is usually easy when the accident occurs at the time of labor, especially if the patient has been under supervision during its course. If she is not seen until later the characteristic history and the collapse are almost pathognomonic, the only other conditions in which the latter is noted before delivery being in cases of rupture of an advanced extra-uterine pregnancy, or of the premature separation of the normally implanted placenta.

If the child has escaped into the abdominal cavity it is much more readily felt on palpation than usual, while on one side of it the hard, rounded body of the uterus can be detected. Moreover, vaginal examination frequently reveals the existence of a tear in the uterine wall through which the fingers can be passed into the abdominal cavity, where they come in contact with the intestines. Again, the fact that the presenting part can no longer be felt is conclusive evidence that the foetus has escaped from the uterus.

**Prognosis.**—The chances for the child are almost uniformly bad, since



it frequently succumbs before the occurrence of the accident. On the other hand, if it has survived up to that time, its only chance of living is afforded by immediate extraction, asphyxia, the result of the separation of the placenta, being otherwise inevitable. If left to themselves, the vast majority of the mothers die from hæmorrhage or infection, although spontaneous recovery has been noted in exceptional cases. In the 23 cases reported by Scipiadès, which came to autopsy, death was due to infection in 52 per cent., to hæmorrhage in 39 per cent., and to hæmorrhage and shock in 44 per cent.

Death from hæmorrhage usually occurs within the first few hours, though occasionally it may be deferred for forty-eight hours; in infection the fatal termination may not occur for some days.

Spontaneous recovery is least likely when the child has escaped into the abdominal cavity, though isolated instances are on record in which the patient has survived even such an accident. In such circumstances the child is usually surrounded by foetal membranes, and after its death may undergo any one of the several eventualities mentioned in the chapter on Extra-uterine Pregnancy. So far as the women are concerned, even if properly treated, the mortality is very high, at least one-third succumbing.

**Treatment.**—(a) *Prophylactic.*—Intelligent care of the lying-in woman should almost entirely do away with this accident. Accordingly, it occurs very rarely in well-regulated hospitals and comparatively frequently in the homes of the poor—in Scipiadès' series of 91 cases the respective incidence was 0.046 and 0.53 per cent. Whenever there is a possibility of the existence of an obstacle to the birth of the child, the obstetrician should always be on the alert for symptoms indicative of impending rupture. Transverse presentations should be promptly delivered by version as soon as the cervix is fully dilated; in head presentations failure of engagement after one hour of strong second-stage pains should be regarded with suspicion, and if the contraction ring rises up labor should be promptly terminated by the most conservative procedure. In neglected cases decapitation in transverse and craniotomy in head presentations often promise the best results. Such procedures are the more justifiable in the circumstances, as the children are usually either already dead or have been exposed to such danger that their chances of being delivered alive are very slight.

(b) *Curative.*—If the child is alive and still within the uterus, or if it has already escaped into the abdominal cavity, no attempt should be made to extract it *per vaginam*, but laparotomy should be immediately performed, and followed, after removal of the child, by whatever operative procedures may be deemed necessary—suture of the tear, supravaginal amputation, or total removal of the uterus.

On the other hand, if the child is dead and still within the uterus, delivery may be effected by the natural passages by the most feasible and conservative procedure, after which, as well as in those cases which are not seen until after delivery *per vaginam* and in which the uterine rupture was not recognized until afterwards, various procedures have been suggested by different authorities.

Personally, I believe that in hospital practice the best results will fol-



Traumatic rupture occurs relatively frequently when version is attempted in neglected transverse presentations. The proper treatment of this class of cases requires the utmost nicety of judgment, as it is oftentimes extremely difficult to determine whether the lower uterine segment is so thinned out as to contra-indicate attempts at version, the operation being sometimes readily accomplished under anæsthesia in cases in which, at first sight, it had appeared impracticable; whereas, in others, in which it seemed that the necessary manipulations would be without danger, rupture followed the mere introduction of the hand. Moreover, there is a marked difference in the rapidity with which overstretching of the lower uterine segment comes about, the condition supervening very rapidly in some cases, while in others many hours of strong, second-stage pains may be necessary for its production.

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Palpation or vaginal examination shows that the presenting part has slipped away from the superior strait and has become movable, while a hard, round body, which represents the firmly contracted uterus, can be



felt alongside of the foetus. Naturally, if the uterine contents have escaped into the abdominal cavity, the presenting part cannot be felt on vaginal examination.

As a rule, shortly after the occurrence of complete rupture, the patient presents symptoms of collapse, the pulse increases markedly in rapidity, loses tone, and takes on a filiform character, the face becomes pallid, assumes a drawn appearance, and is often covered with beads of sweat. If the hæmorrhage has been copious, she may complain of chilliness, disturbances of vision, and air hunger, and eventually pass into an unconscious state. Symptoms of collapse, however, do not always appear immediately, but are sometimes deferred for several hours after rupture, being less marked when the child remains partially within the uterus. After incomplete rupture, on the other hand, the immediate symptoms are sometimes very slight, but increase in severity as the subperitoneal hæmatoma becomes larger, while actual symptoms of collapse frequently do not appear until secondary rupture into the peritoneal cavity has taken place.

Occasionally after incomplete rupture, emphysematous crackling can be elicited in the tissues of the anterior abdominal wall, 14 cases of this character having been collected by Dischler. It is probably usually due to the invasion of the subperitoneal connective tissue by *Bacillus aerogenes capsulatus*. It is true that bacteriological proof has not been adduced in support of this statement, but the fact that the women had been in labor for many hours, and that many of the children were more or less putrefied, speaks strongly in favor of such a view.

**Diagnosis.**—In cases of spontaneous rupture during pregnancy the diagnosis is not always easy. If accompanied by profuse hæmorrhage, the profound collapse should at once lead to a provisional diagnosis, but in other cases the condition usually escapes detection until the appearance of peritonitic symptoms. Generally speaking, it may be said that a rapid pulse, slight elevation of temperature, and abdominal distention associated with very distinct palpation of the foetus, should always be regarded with grave suspicion, particularly when preceded by a history of traumatism.

On the other hand, the diagnosis is usually easy when the accident occurs at the time of labor, especially if the patient has been under supervision during its course. If she is not seen until later the characteristic history and the collapse are almost pathognomonic, the only other conditions in which the latter is noted before delivery being in cases of rupture of an advanced extra-uterine pregnancy, or of the premature separation of the normally implanted placenta.

If the child has escaped into the abdominal cavity it is much more readily felt on palpation than usual, while on one side of it the hard, rounded body of the uterus can be detected. Moreover, vaginal examination frequently reveals the existence of a tear in the uterine wall through which the fingers can be passed into the abdominal cavity, where they come in contact with the intestines. Again, the fact that the presenting part can no longer be felt is conclusive evidence that the foetus has escaped from the uterus.

**Prognosis.**—The chances for the child are almost uniformly bad, since



it frequently succumbs before the occurrence of the accident. On the other hand, if it has survived up to that time, its only chance of living is afforded by immediate extraction, asphyxia, the result of the separation of the placenta, being otherwise inevitable. If left to themselves, the vast majority of the mothers die from hæmorrhage or infection, although spontaneous recovery has been noted in exceptional cases. In the 23 cases reported by Scipiades, which came to autopsy, death was due to infection in 52 per cent., to hæmorrhage in 39 per cent., and to hæmorrhage and shock in 44 per cent.

Death from hæmorrhage usually occurs within the first few hours, though occasionally it may be deferred for forty-eight hours; in infection the fatal termination may not occur for some days.

Spontaneous recovery is least likely when the child has escaped into the abdominal cavity, though isolated instances are on record in which the patient has survived even such an accident. In such circumstances the child is usually surrounded by foetal membranes, and after its death may undergo any one of the several eventualities mentioned in the chapter on Extra-uterine Pregnancy. So far as the women are concerned, even if properly treated, the mortality is very high, at least one-third succumbing.

**Treatment.**—(a) *Prophylactic.*—Intelligent care of the lying-in woman should almost entirely do away with this accident. Accordingly, it occurs very rarely in well-regulated hospitals and comparatively frequently in the homes of the poor—in Scipiades' series of 91 cases the respective incidence was 0.046 and 0.53 per cent. Whenever there is a possibility of the existence of an obstacle to the birth of the child, the obstetrician should always be on the alert for symptoms indicative of impending rupture. Transverse presentations should be promptly delivered by version as soon as the cervix is fully dilated; in head presentations failure of engagement after one hour of strong second-stage pains should be regarded with suspicion, and if the contraction ring rises up labor should be promptly terminated by the most conservative procedure. In neglected cases decapitation in transverse and craniotomy in head presentations often promise the best results. Such procedures are the more justifiable in the circumstances, as the children are usually either already dead or have been exposed to such danger that their chances of being delivered alive are very slight.

(b) *Curative.*—If the child is alive and still within the uterus, or if it has already escaped into the abdominal cavity, no attempt should be made to extract it *per vaginam*, but laparotomy should be immediately performed, and followed, after removal of the child, by whatever operative procedures may be deemed necessary—suture of the tear, supravaginal amputation, or total removal of the uterus.

On the other hand, if the child is dead and still within the uterus, delivery may be effected by the natural passages by the most feasible and conservative procedure, after which, as well as in those cases which are not seen until after delivery *per vaginam* and in which the uterine rupture was not recognized until afterwards, various procedures have been suggested by different authorities.

Personally, I believe that in hospital practice the best results will fol-



low laparotomy, no matter what the character of the tear, or the extent of the hæmorrhage; for the reason that it is often difficult to determine the extent of the laceration, and furthermore that it is absolutely impossible to foretell whether the hæmorrhage can be controlled by simple procedures; and, even if these succeed, whether the result will be permanent. I therefore agree with Fritsch, Varnier, Zweifel, and Munro Kerr, who hold that it is only by opening the abdomen that one can be assured against all further risk of hæmorrhage. On the other hand, in outside practice, and particularly in cases of incomplete rupture, radical surgical treatment is usually inadvisable, so that, after delivering the child and placenta, one must be content with the employment of palliative measures.

Many authorities, however, agree that, inasmuch as the danger to be apprehended in cases of incomplete rupture is hæmorrhage, laparotomy should be performed only when the loss of blood is profuse, but that in all other cases equally good, if not better, results may be obtained by draining or packing the rupture from the vagina. Schmit, Klien, Scipiades, and others have collected large series of cases which apparently bear out this contention.

My own experience leads me to believe that it is usually irrational to adopt such procedures as a matter of choice, as occasionally women who are apparently in excellent condition shortly after the occurrence of the rupture may begin to bleed profusely some hours later, and may die before operative measures can be instituted. Furthermore, I do not believe that the statistical evidence thus far adduced gives a correct idea of the relative merits of the two methods of treatment, for the reason that packing is usually employed in the milder and more favorable cases, while radical surgical measures are practically limited to the desperate cases, which would naturally lead one to overestimate the dangers of radical intervention.

#### INSTRUMENTAL PERFORATION OF THE UTERUS

Reference has already been made to perforation of the uterus following attempts at criminal abortion or in the effort to remove placental tissue by means of the curette or polypus forceps, after an incomplete abortion. Similar accidents likewise occasionally occur as the result of want of skill on the part of the obstetrician in full-term labor, when either the uterus or the vaginal vault may be perforated. As has already been pointed out, in cases of this character, loops of intestine frequently prolapse through the rupture. Under such circumstances laparotomy is the ideal treatment, though, in the absence of prolapse of the intestines, cases are recorded in which recovery occurred spontaneously under what were apparently most unfavorable circumstances.

#### PERFORATION OF THE GENITAL TRACT FOLLOWING NECROSIS

In obstructed labor the tissues in various portions of the genital tract may be forcibly compressed between the head and the bony canal. If the

pressure is transitory it is without significance; but if it is long continued necrosis results, and after a few days the area implicated sloughs away so that perforation follows.

In most cases of this character the perforation occurs between the vagina and the bladder, giving rise to a *vesico-vaginal fistula*. Less frequently the anterior lip of the cervix is compressed against the symphysis pubis, and an abnormal communication is eventually established between the cervical canal and the bladder—*cervico-vesical fistula*.

If the patient is not infected the fistulous tract frequently heals without further treatment. In other cases, however, it may persist, when a subsequent plastic operation becomes necessary for its cure.

Occasionally the posterior wall of the uterus may be subjected to so much pressure against the promontory of the sacrum that necrosis results, and a connection is established with Douglas's *cul-de-sac*. If infection occurs the accident is usually followed by septic peritonitis. Fortunately, recovery usually follows without further complications, inasmuch as a localized peritonitis leads to the formation of adhesions between the posterior wall of the uterus and the pelvic peritoneum, thereby doing away with the possibility of a general peritoneal infection. It should be remembered that similar lesions may occur in the rare cases in which exostoses or bony spicules protrude from the walls of the birth canal, as in *pelvis spinosa*.

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## CHAPTER XLII

### PROLAPSE OF THE UMBILICAL CORD—ASPHYXIA NEONATORUM— SUDDEN DEATH DURING LABOR

#### PROLAPSE OF THE UMBILICAL CORD

It is customary to distinguish between *presentation* and *prolapse of the funis* or umbilical cord. In the former the cord can be palpated through the intact membranes, while in the latter a loop of it protrudes through the cervix into the vagina, and exceptionally emerges from the vulva.

In general it may be said that any factor which interferes with the accurate adaptation of the presenting part to the superior strait predisposes to prolapse of the cord. Accordingly, the accident occurs most commonly in transverse and foot, and less often in frank breech presentations. On the other hand, it is rarely observed when the child presents by the head, unless accommodation is interfered with as a result of a contracted pelvis, excessive development of the foetus, hydramnios, or abnormal flaccidity of the lower uterine segment. For this reason it is much more common in multiparous than in primiparous women.

Prolapse of the cord is without appreciable effect upon the course of labor so far as the mother is concerned. On the other hand, it is one of the most frequent causes of foetal death, compression between the presenting part and the pelvic wall interfering with the circulation to such an extent that asphyxia and inevitable death often follow unless prompt delivery is effected. The danger is greater in vertex than in other presentations, for the reason that there is less likelihood that the cord will escape compression when the pelvic canal is filled out by the hard, rounded head than by the softer and more irregularly shaped part in other presentations.

Presentation of the funis is diagnosed when on palpation a soft, pulsating, cord-like body can be felt through the membranes. In many instances, however, its recognition is only possible when the cord is in direct contact with the presenting part.

Prolapse of the cord, on the other hand, is readily recognized, since on vaginal examination the fingers come directly in contact with a loop, while exceptionally the structure may protrude from the vulva. Mistakes are hardly possible if the foetus is alive, as distinct pulsations are felt, although in their absence the condition is sometimes overlooked on superficial examination.

The possibility of prolapse of the cord should be particularly borne in



mind in multiparous women in whom the membranes rupture while the head is still freely movable above the superior strait. In such cases the sudden cessation of the foetal heart-beat renders the diagnosis almost certain, even without vaginal examination.

**Treatment.**—The treatment to be pursued in any given case depends mainly upon the degree to which the cervix is dilated, and to a lesser extent upon the presentation of the child. In cases of presentation of the funis there is no immediate danger of compression so long as the membranes remain intact, and for this reason every precaution should be taken to avoid their premature rupture, vaginal examinations being made with the utmost gentleness. At the same time the obstetrician should hold himself in readiness to effect delivery as soon as the cervix is sufficiently dilated.

In prolapse of the cord, provided dilatation is complete, the life of the child can often be saved by prompt delivery. In cephalic presentations this can usually be effected more rapidly by version than by forceps, unless the head is already deep down in the pelvic canal. In breech presentations a foot should be brought down and followed immediately by extraction. In transverse presentations version is indicated.

On the other hand, when the cervix is only partially dilated, the chances of a favorable outcome for the child are markedly diminished. If the head is not deeply engaged the patient should be placed in the knee-chest position, the entire hand introduced into the vagina, and an attempt made to push the cord up into the uterus and, if possible, to carry it over some projecting portion of the child's body. If the cord remains in the uterus the patient should be made to lie upon the side toward which the child's back is directed in the hope of avoiding compression.

In the majority of cases, however, the prolapse recurs again as soon as the hand is removed. In such circumstances an improvised repositor will sometimes serve us in good stead, although the results attending its use are usually unsatisfactory. A piece of bobbin is firmly attached to the free end of a sterile bougie in such a manner as to leave a loop several inches long. This is then passed around the prolapsed cord and slipped over the tip of the bougie. By this means the cord can readily be carried up into the uterus, after which it may be freed from the repositor by bringing the loop in contact with a portion of the child and making traction upon it so as to cause it to slip off from the tip of the bougie. In the great majority of cases the condition recurs as soon as the repositor is removed; to insure against such an accident the bougie may be left in the uterus.

Occasionally the tendency to prolapse may be overcome by placing the patient in the knee-chest position until engagement of the presenting part occurs, when the cord cannot get past it. In most cases, however, these manœuvres prove ineffectual, and, unless the resistance offered by the cervix can be promptly overcome, the death of the child becomes almost inevitable in vertex, and only somewhat less so in breech and transverse presentations.

In exceptional cases, if the child is in good condition, excellent results may be obtained by manual dilatation of the cervix, or by vaginal hysterotomy, followed by prompt version and extraction. On the other hand, if the pulsations in the cord are weak or have ceased altogether, such a pro-

cedure should not be adopted, inasmuch as the child has either already perished or will die before delivery can be effected. If, however, the cervix is fully dilated, such limitations do not hold good, as occasionally a child that is apparently hopelessly lost may be rescued.

### ASPHYXIA

Normally the foetus while it remains in the uterus is in a condition of apnoea, being satisfactorily supplied with oxygen by means of the placental circulation. As soon as delivery occurs, owing to the separation of the placenta or to the great diminution in its area of attachment, this source of oxygen is entirely cut off, or so greatly reduced that the necessity for active respiration arises. Generally speaking, imperfect oxygenation should be considered as the primary factor in the establishment of this function, although numerous accessory causes come into play during the act of delivery and just after birth.

Exceptionally, as the result of compression of the prolapsed cord, premature separation of the placenta, or much less commonly of tetanic contraction of the uterus, the normal supply of properly aerated blood through the umbilical vessels may be cut off or interfered with while the child is still within the uterus. Occasionally a similar condition may be brought about by compression against the symphysis of a cord which is wrapped around the neck of the child, while now and again asphyxia and even death may result when the head is on the perineum, owing to excessive retraction of the active segment of the uterus, with a consequent diminution in the area of placental attachment.

As a result of the action of any of these factors the child may take its first breath while still in the uterus or in the lower portion of the birth canal. In the former case it may draw a certain quantity of amniotic fluid into its lungs, and when respiration begins while the head is in the vagina, a certain amount of mucus is liable to be aspirated. In either event the needed oxygen is not obtained, and the resulting air hunger leads to increased respiratory efforts, which are nevertheless of no avail. Gradually the accumulation of carbon dioxide and other excrementitious materials in the foetal organism leads to such a pronounced decrease in the irritability of the medulla that eventually the attempts at respiration cease, the intervals between the pulsations of the heart become longer and longer, and the child dies from asphyxia.

Again, pressure exerted upon the brain in difficult labors or in operative procedures may lead to vagus irritation and consequent slowing of the heart. As a result of the interference with the foetal circulation the blood becomes poorer in oxygen and richer in excrementitious material; this goes on until at last the irritability of the medulla becomes so lowered that the usual stimuli fail to call forth the first respiratory movement and asphyxia results.

The most frequent causes of cerebral compression are attempts on the part of the uterus to force the head through a contracted superior strait, excessive pressure exerted by the blades of the forceps, and intra-cranial hæmorrhage. When limited to the cerebral hemispheres a very consider-



able effusion of blood may occur without exerting a deleterious effect upon the fœtus; but if the base of the brain is implicated a much smaller amount may give rise to serious disturbances.

**Diagnosis.**—The importance of watching for manifestations pointing to threatened intra-uterine asphyxia cannot be overestimated, inasmuch as their recognition frequently affords the indication for operative delivery, without which the life of the child is inevitably lost.

The most characteristic symptom is afforded by changes in the fœtal pulse-rate. At first, as a result of momentary compression of the brain or interference with the placental circulation, it becomes slower with each uterine contraction, but regains its normal frequency in the intervals between the pains. As the condition becomes more serious, the remissions fail to occur and the pulse becomes slower and slower and eventually the heart ceases to beat. For practical purposes it is well to assume that a pulse-rate of 100 or less is incompatible with prolonged life for the fœtus, and under such circumstances rapid delivery is indicated, provided it can be accomplished without too great risk for the mother. Exceptionally, the first sign of asphyxia is a marked increase in the frequency of the fœtal pulse, which may vary from 160 to 200. The acceleration, however, is only transient, and, as a rule, soon gives place to a marked slowing, which becomes still more perceptible as the fatal termination is approached.

In vertex presentations another characteristic sign of impending asphyxia is the escape of meconium. This is due to relaxation of the sphincter ani muscle induced by faulty aeration of the blood. In breech presentations, of course, this symptom is without significance, and is to be regarded as a purely mechanical result of pressure applied to the abdomen of the fœtus. Accordingly, whenever the amniotic fluid in a vertex presentation presents a yellowish-green appearance and contains flakes of meconium, we may conclude that the child is in danger, and that the only hope for its safety lies in prompt delivery.

Especially in difficult breech extractions, when delay is experienced in delivering the head, signs of asphyxia may appear in a child which was apparently in excellent condition before the operation. In such circumstances the finger in the child's mouth can readily appreciate the fact that vigorous inspiratory movements are being made. A similar phenomenon may occasionally be observed in vertex presentations, when the head is arrested on the pelvic floor, the movements of the mouth being felt or seen through the thinned-out perineum.

Very exceptionally the child may not only make inspiratory efforts, but actually give utterance to sounds *in utero*—*vagitus uterinus*. For the production of this phenomenon it is essential that air gain access to the fœtus, its entrance into the uterus sometimes resulting from the introduction of the hand or instruments. A very characteristic example of this phenomenon has been recorded by Bucura, who has collated the literature bearing upon the subject up to 1904.

After delivery the asphyxiated child may present one of two appearances—*asphyxia pallida* or *asphyxia livida*. In both respiration is in abeyance or occurs only in gasps, while the heart beats slowly and feebly. In

the former the surface of the body is pale and cold, the extremities hang limp, and the child fails to respond to the usual external stimuli. In the latter, on the other hand, it presents a congested or livid appearance, which is usually attributed to overdistention of the right heart and the inferior vena cava. This form of asphyxia is usually more amenable to treatment than the pallid variety.

**Prognosis.**—Asphyxia neonatorum is always serious. The prognosis is relatively favorable when the condition is due to mechanical interference with the placental circulation, but is far less so when it results from injuries to the brain, such as intra-cranial hæmorrhage, fractures, or depressions of the skull.

**Treatment.**—Normally, the child should make its first inspiratory movement a few moments after it emerges from the vulva. If this does not occur, the feet being grasped by the fingers of one hand and the child suspended with its head downward, its body should be slapped vigorously with the other. If this manœuvre does not prove immediately successful, and particularly if attempts at respiration are associated with a gurgling sound, a finger should be passed to the back of the pharynx for the purpose of removing any foreign material which may interfere with the free access of air to the laryngeal opening. Ordinarily, if the child is not deeply asphyxiated, these measures will bring about the desired results; but if they fail artificial respiration should at once be instituted, the child's thorax being compressed 5 or 6 times to the minute.

In some instances, however, more radical measures will be found necessary. In such cases the cord should be ligated and cut through, and the child immersed in hot and cold water alternately, with only its head protruding, and rubbed vigorously. If there is any reason to believe that the trachea and larger bronchi contain mucus or amniotic fluid, a small, soft-rubber catheter should be introduced into the larynx and the offending material removed by suction exerted by the obstetrician, or by the employment of a Ribemont-Dessaigues insufflator.

If these measures do not lead to the establishment of respiration, the child should be wrapped in a piece of blanket or flannel to prevent too rapid cooling, and laid upon a table or chair, the head being allowed to hang over the edge. The tip of the tongue is then grasped by a small pair of artery forceps and drawn forward as far as possible and then allowed to recede, the manœuvre being repeated at regular intervals 10 or 12 times to the minute. After the first few tractions an inspiratory movement usually follows, after which respiration goes on regularly. This procedure, known as *Laborde's method of resuscitation*, is based upon the principle that traction upon the tongue irritates the fibers of the superior laryngeal, glossopharyngeal, and lingual nerves, which in turn give rise to a reflex stimulation of the phrenic nerves with consequent contraction of the diaphragm and the intercostal muscles. Generally speaking, it is the most effective measure at our disposal, and the prognosis becomes extremely gloomy if its employment is not attended by satisfactory results within a few minutes. Occasionally its efficiency may be heightened by practicing it with the child immersed in a hot bath.



Before, however, despairing of saving the child's life recourse may be had to *Schultze's method*.



Fig. 659.



Fig. 660.

In this manœuvre, as shown in Figs. 659 and 660, the child is seized by both hands in such a manner that the index fingers of the operator lie under its axillæ, the thumbs over the thorax, while the palmar surfaces of the remaining fingers are applied to its back, the head at the same time being fixed by the balls of the thumbs. The obstetrician stands with his legs apart and at first allows the fœtus to hang down between them, he then slowly carries the child over his head in such a manner that the legs fall toward its face, so that the body becomes sharply flexed, after which he brings it back to its original position. The manœuvre is repeated 4 or 5 times a minute. The *rationale* of the method is readily appreciated: the thorax is markedly compressed when the child is elevated, and expanded when it is lowered, the two positions favoring expiration and inspiration respectively.

Some idea of its efficiency may be gained by the fact that, when it is practiced upon a dead child, air can be distinctly heard to enter and leave the lungs with each movement, and Schultze, in 1911, still contends that it is the most efficient method at our disposal. The procedure, however, is not without disadvantages; for, if too violently employed, it sometimes give rise to fracture of the clavicles or ribs, and occasionally to rupture of the liver or other serious lesions of the internal organs. Moreover, in view of the no small degree of violence associated with its use, the manœuvre is contra-indicated when the clavicle or humerus has been fractured during a difficult extraction, inasmuch as the free ends of the bones are liable to cause serious injury to the soft parts.

Byrd, in 1874, and Dew, in 1893, suggested a convenient substitute for Schultze's method. The latter recommended that the child be grasped with the left hand, allowing the neck to rest between the thumb and forefinger so that the head falls far backward; while the right hand grasps the legs in such a way that the right knee rests between the thumb and forefinger, and the left between

FIGS. 659-660.—SCHULTZE'S  
METHOD OF RESUSCITATION.

the fore and middle fingers, with the back of the thighs resting upon the palm of the hand. In order to bring about inspiration the child is gently bent backward, while the reverse movement compresses the thoracic contents and causes expiration. Dew claims that this method is quite as efficient as that of Schultze, and has the additional advantages that it is less likely to cause injury to the child, and is much less fatiguing to the operator.

In hospital practice satisfactory results may be obtained by the use of the so-called "pulmotor." This is a patented device, by means of which a regulated quantity of pure oxygen gas, under suitable pressure, can be forced into and withdrawn from the lungs, thus effectually stimulating respiration.

As asphyxia livida is associated with over-loading of the right side of the heart, it is sometimes advisable to loosen the ligature at the free end of the cord so as to allow the escape of 15 cubic centimeters of blood. In obstinate cases some authorities recommend the injection of a few drops of whisky or ether, but I have not observed beneficial results following it.

When the asphyxia is the result of a depressed fracture of the skull, the depressed portion should be elevated in the hope of removing the source of compression. Such an operation, however, should be attempted only when the heart still continues to beat strongly, though slowly.

Efforts at resuscitation should be persevered in as long as the heart continues to beat, one method after another being given a trial. The necessity for persistence is shown by the fact that successful results are occasionally obtained after trials lasting for thirty to sixty minutes, or even longer.

### SUDDEN DEATH DURING OR SHORTLY AFTER LABOR

Ordinarily, death occurring during labor, or in the first few hours immediately following it, is the result of some one of the abnormalities to which allusion has already been made, particularly pulmonary embolism, acute oedema of the lungs, apoplexy complicating eclampsia, or acute anaemia the result of post-partum hæmorrhage, placenta prævia, premature separation of the normally implanted placenta, or rupture of the birth canal. This subject was discussed in detail by E. P. Davis in 1905, to whose article the student is referred for an extensive bibliography.

In rare instances incomplete rupture of the uterus is unattended by symptoms at the time of its occurrence, the blood slowly accumulating between the folds of the broad ligament with a gradual development of symptoms of shock. A subperitoneal hæmatoma formed in this way is liable to rupture into the peritoneal cavity at any time within the first forty-eight hours after delivery and lead to sudden death.

Moreover, a woman in labor, or during the puerperium, may die suddenly from the effects of any condition which would give rise to a similar outcome under other circumstances. Thus, cases have been reported in which the fatal termination was due to rupture of an aortic or cardiac aneurism, hæmorrhage from a gastric ulcer, or other accidents. Van der



Velde has reported a case of a fatal retro-peritoneal hæmorrhage complicating an acute pancreatitis, while Node and Hines observed sudden death during labor following the rupture of an aneurysm of the splenic artery.

In the chapter dealing with the Pathology of Pregnancy reference was made to the consequences of labor in women suffering from valvular lesions of the heart, particularly stenosis of the mitral orifice. Less frequently sudden death may be due to fatty degeneration or to changes in the myocardium. Such accidents are to be particularly dreaded in elderly and corpulent women.

**Shock.**—Formerly it was customary to attribute a certain number of deaths following labor to shock, which was supposed to occur in certain individuals after prolonged and very painful labors, the incidental loss of rest, imperfect nutrition, and mental excitement being looked upon as predisposing causes. In the present state of our knowledge, however, this explanation is hardly permissible, since in the majority of such cases a carefully performed autopsy will reveal the existence of some condition sufficiently serious to account for the unfavorable outcome, the most common being hæmorrhage following some severe injury to the genital tract.

**Syncope.**—Faintness is not an uncommon result of exhaustion following prolonged labor, and in neuropathic individuals may occur even after an easy and rapid delivery. In rare instances it may be due to cerebral anæmia resulting from lack of blood in the nervous centers following the sudden diminution in the intra-abdominal pressure incident to the rapid decrease in the size of the uterus.

The faintness usually passes off rapidly and does not lead to untoward results. On the other hand, it occasionally gives cause for serious alarm, the pulse becoming weaker and more rapid and the patient remaining in a condition of profound prostration. I have never seen a death from this cause, but can recall one patient who caused me the greatest possible anxiety, and who was in imminent danger for more than twelve hours.

Haig Ferguson reports 3 cases of serious exhaustion following labor in which he was inclined to attribute the condition to reflex irritation resulting from pressure upon the ovaries incident to the improper employment of Credé's method of expressing the placenta, the organ being grasped laterally instead of antero-posteriorly.

**Profound Mental Depression.**—In rare instances the only apparent explanation for death, or for a profound collapse which eventuates in recovery, is to be found in the mental condition of the patient, since the most careful examination, both at the bedside and at autopsy, may fail to reveal the slightest abnormality.

I recall a case in my own practice which apparently belongs in this category. The patient, who was unhappily married, had already passed through two very difficult labors. When I saw her, in the latter part of the first stage of her third labor, she was about the room. Just before going to bed at the beginning of the second stage she asked the nurse and myself to witness her will, as she said she felt sure she would not recover. The labor was rapid and uneventful, the placenta coming away spontaneously, and everything appearing to be most satisfactory. On approach-



ing the bed to take leave of the patient an hour later, I was struck with her haggard appearance. Fearing the possibility of hæmorrhage I at once applied my hand over the uterus and found it tightly contracted, while the pulse was of excellent quality. Without any apparent reason, and in spite of energetic stimulation and the subcutaneous administration of salt solution, the patient grew slowly worse, the pulse becoming rapid and weak, the eyes sinking back in their sockets, and the face assuming a drawn and Hippocratic expression.

The most careful examination failed to reveal the slightest cause for the condition. The hand introduced into the uterus could find no trace of rupture. Eight hours after delivery I requested a colleague to see her in consultation, but he also was unable to offer any explanation. It then occurred to me that the condition might possibly be the result of her morbid forebodings, and acting upon this supposition I administered a large dose of morphine hypodermically, which was promptly followed by sound sleep, a marked improvement in the character of the pulse, and a rapid change for the better in the general appearance. Upon awaking a few hours later the patient felt very comfortable and made an uninterrupted recovery.

**Pulmonary Embolism.**—This accident, usually noted only later in the puerperium, but occasionally occurring shortly after labor, is due to the detachment of a small particle of thrombus situated in a uterine or pelvic vein or elsewhere, which is carried to the right side of the heart and leads to more or less complete occlusion of the pulmonary artery. It is usually associated with infective or thrombotic processes elsewhere in the body, though it may occur in women who were apparently perfectly well. Davis considers it the most frequent cause of sudden death in the absence of definite disease. Under such circumstances the patient complains of intense and sudden precordial pain, becomes livid in appearance, and presents symptoms of profound dyspnoea and eventually of air hunger. These embolisms, however, are not always fatal, a small proportion of the patients recovering.

The treatment is purely palliative. The woman should be placed in the recumbent position, stimulants by the mouth and salt solution subcutaneously should be administered. Inhalations of oxygen, if obtainable, are also indicated.

**Entrance of Air into the Uterine Sinuses.**—Certain cases of death following intra-uterine manipulations in women suffering from placenta prævia or rupture of the uterus are attributed by many authorities to the entrance of air into the uterine sinuses, whence it is carried to the heart. The exact cause of death is not understood, some holding that the air bubbles enter the coronary arteries, and others that the right heart, being unable to rid itself of them, becomes paralyzed as a result of its fruitless efforts. The symptoms are analogous to those following pulmonary embolism. Cases of this character have been reported by Olshausen, Lesse, Perkins, Roger, and others.

\*That such a condition occasionally occurs is clear from the fact that several cases have been reported in which sudden death followed the pump-



ing of air into the pregnant uterus for the purpose of producing abortion. On the other hand, it is probable that its frequency has been over-estimated, as most of the cases which have come to autopsy, and which were supposed to demonstrate such a possibility, are open to another and far more reasonable explanation. Thus, G. W. Dobbin was able to demonstrate the presence of *Bacillus aerogenes capsulatus* in the tissues from one of Perkins's cases, in which the presence of air bubbles in the blood-vessels had been regarded as satisfactory evidence as to the cause of death. Wendeler had a similar experience, and it would therefore seem permissible to regard with scepticism all cases of supposed air embolism in which death did not occur almost instantaneously, or in which careful bacteriological investigation demonstrated the presence of gas bacilli.

**Acute Dilatation of the Stomach.**—Very exceptionally following an operative and sometimes a spontaneous labor, the patient may pass into a condition of profound shock, associated with symptoms of acute dilatation of the stomach—great distention of that organ and the expulsion of immense quantities of dark fluid vomitus—and death may follow, or recovery ensue, just as in the similar condition, which is so well known to surgeons.

I have encountered the complication upon one occasion. In this instance an apparently perfectly healthy woman, one hour after the completion of a relatively easy spontaneous labor, passed into a condition of profound shock and hovered between life and death for 24 hours. The first manifestation was a marked change in the character and rate of the pulse, but the true condition was not suspected until the onset of the characteristic vomiting a few hours later.

Audebert, in 1912, was able to collect 12 cases from the literature. As labor was spontaneous in three of them, he was inclined to attribute the condition to paralysis of the stomach due to the action of chloroform. In my case, as the patient received only a minimal amount of the drug, I sought the ætiological factor in an arterio-duodenal occlusion following the acute diminution in the bulk of the abdominal contents, incident to the sudden decrease in the size of the uterus. Whatever the cause may be, the condition is most serious, and now that attention has been called to its possibility it should be recognized as one of the causes for sudden death following delivery. The best results are obtained by placing the patient in an inclined position, with the head considerably lower than the feet, emptying the stomach by a suitable tube, and stimulating according to the exigencies of the case.

**Post-mortem Delivery.**—In the literature, which has been carefully searched by Aveling and Reimann, a number of cases are recorded in which spontaneous birth of the child took place some hours or days after the death of the mother. Moreover, delivery sometimes occurs after burial, and, when the body has been exhumed for some reason, two individuals instead of one have been found in the coffin. These are instances of the so-called "coffin birth." The phenomenon is usually observed in multiparous women in whom the vaginal outlet is markedly relaxed, and is supposed to be due to a marked increase in the intra-abdominal pressure pro-

duced by putrefactive changes, though certain authorities are inclined to attribute isolated cases to rigor mortis of the uterine musculature.

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## SECTION VIII

### *PATHOLOGY OF THE PUERPERIUM*

#### CHAPTER XLIII

##### PUERPERAL INFECTION

Under the general heading of "puerperal infection" are now included all the various morbid conditions which result from the entrance of infective micro-organisms into the female generative tract during labor or the puerperium. The older term, "puerperal fever," is at once too vague and misleading, and for many reasons should be discarded. In the first place it suggests the old idea of the essentiality of the affection so strongly urged by the late Fordyce Barker, and takes no account of the various ætiological factors which may be concerned. Moreover, it emphasizes the febrile phenomena of the affection, instead of laying stress upon its infectious nature and the consequent responsibility of the obstetrician and his assistants. Again, "puerperal septicæmia" and "puerperal sepsis," which are often used as synonymous terms, are hardly less satisfactory, inasmuch as in many instances the infection results in perfectly localized inflammatory processes, to which such terms cannot be applied without violating the established rules of diction.

It is probable that puerperal infection has occurred almost as long as children have been born, and passages in the works of Hippocrates, Galen, Avicenna, and many of the old writers clearly have reference to it. As early as 1676 Willis wrote on the subject of *febris puerperarum*, but the English term "puerperal fever" was probably first employed by Strother in 1718.

The ancients regarded the affection as the result of retention of the lochia, and for centuries this explanation was universally accepted. In the early part of the seventeenth century Plater showed that it was essentially a metritis, and was followed in the next century by Puzos with his milk metastasis theory. From the time of Plater, until Semmelweis proved its identity with wound infection, and Lister demonstrated the value of antiseptic methods, all sorts of theories were suggested concerning its origin and nature, which are comprehensively dealt with in the monographs of Eisenmann, Silberschmidt, and Burtenshaw.

**Bacteriology.**—Although Charles White (1793) and Alexander Gordon (1795) clearly recognized the contagious nature of puerperal infection, and

many other British observers had vague ideas upon the subject, it was not until the middle of the nineteenth century that such views were strongly urged. In 1843 Oliver Wendell Holmes read a paper before the Boston Society for Medical Improvement, entitled "The Contagiousness of Puerperal Fever," in which he clearly urged that at least the epidemic forms of the affection could always be traced to the lack of proper precautions on the part of the physician or nurse. Four years later Semmelweis, then an assistant in the Vienna Lying-in Hospital, began a careful inquiry into the causes of the frightful mortality attending labor in that institution, as compared with the comparatively small number of women succumbing to puerperal infection when delivered in their own homes. As a result of his observations he concluded that the morbid process was essentially a wound infection, and was due to the introduction of septic material by the examining finger. Acting upon this idea he issued stringent orders that the physicians, students, and midwives should disinfect their hands with chlorine water before examining parturient women. In spite of almost immediate surprising results—the mortality falling from over 10 to about 1 per cent.—his work, as well as that of Holmes, was scoffed at by many of the most prominent men of the time, and his discovery remained unappreciated until the influence of Lister's teachings and the development of bacteriology had brought about a revolution in the treatment of wounds.

It is now universally acknowledged that puerperal infection is wound infection, and is due to the invasion of the generative tract by various pyogenic bacteria. The principal micro-organisms concerned are the following:

(a) *Streptococcus*.—As early as 1865 this organism was observed in the tissues of women who had died during the puerperium by Mayrhofer, whose findings were confirmed by Coze and Feltz, Recklinghausen, Waldeyer, Klebs, Orth, and Heiberg. Pasteur, in 1880, however, was the first to cultivate streptococci from cases of puerperal infection, and he called them "chapelets en grains." He was assisted by Doléris, who carried the work still further, and showed that the streptococcus was generally the infectious agent, but that other bacteria were sometimes concerned. These researches were soon confirmed by Lomer, Bumm, Döderlein, Winter, Widal, and by all subsequent observers, so that it is now believed to be the usual cause of the epidemic and fatal forms of puerperal infection.

In 1903, Schottmüller showed when streptococci, obtained from seriously ill patients, were grown upon blood-agar that each colony became surrounded by an area of hæmolysis, which was lacking in the saprophytic varieties of the organism. As his findings were confirmed by Fromme, Gonnet, and others, it was believed for a time that three types could be differentiated—*streptococcus pyogenes*, *streptococcus mitior* or *gracilis*, and *streptococcus mucosus*. It was held that the first, which was always hæmolytic, was concerned in the production of virulent infections, while the other two varieties were lacking in hæmolytic properties, and were either saprophytic or only slightly pathogenic in character.

The work of Natwig, Lea and Sidebotham, and others has shown that these conclusions are too sweeping, and that while hæmolytic streptococci



are usually virulent, they are not always so. Furthermore, the non-hæmolytic variety is occasionally highly pathogenic; and, as the hæmolytic properties may either be lost or accentuated by various cultural methods, it would appear inadvisable to consider the existence of such properties as characteristic of an absolutely distinct species of streptococcus.

Although Krönig, myself, and others had previously isolated an anaerobic streptococcus, it was not until 1910 that Schottmüller demonstrated its practical importance. By the use of suitable anaerobic culture media he was able to isolate it in many cases, and even concluded that it was more frequently concerned in the production of puerperal infection than the ordinary aerobic variety. As the organism produced large amounts of sulphuretted hydrogen he designated it as the streptococcus putridus. Bondy and others have made similar observations, but much more extensive investigation will be required before it will be possible to accept Schottmüller's conclusions without question.

(b) *Staphylococcus*.—Further investigation gradually demonstrated the fact that the streptococcus is not necessarily the only organism which may be concerned, but that most of the pus producers, which give rise to wound infection in other parts of the body, may likewise at times be the exciting factors.

Brieger, in 1888, reported that he had demonstrated *Staphylococcus aureus* in five fatal cases. Doléris stated, in 1880, that he had been able to cultivate in pure culture cocci arranged in groups or bunches, but it was not until 1894 that he stated definitely that they were staphylococci.

The statement made by Fehling and Haegler that staphylococci usually give rise to mild forms of infection has not been borne out by the observations of other investigators. Occasionally mixed infections are observed; association with the streptococcus being reported by Döderlein, and Bar and Tissier, and with the colon bacillus by Marquis. It appears that *Staphylococcus aureus* is the variety observed in puerperal infection, the albus and citreus playing little or no part in its production.

(c) *Gonococcus*.—Although clinicians had long suspected that gonorrhœa frequently plays a part in the production of puerperal infection, Krönig was the first to adduce bacteriological proof of its action. In 1893 he reported 9 cases of mild infection, in all of which he was able to obtain pure cultures of gonococci from the uterine lochia. In a later communication he stated that he had been able to cultivate the same organism from the discharges of 50 out of 179 patients presenting febrile puerperia, and that most of them recovered spontaneously.

Krönig's experience has been confirmed by all subsequent investigators, and Taussig, and Stone and McDonald state respectively that probably one sixth to one tenth of all rises of temperature in the puerperium are the result of gonorrhœal infection. As far as I am aware Foulerton and Bonney are the only recent writers who have not had a similar experience. I have repeatedly been able to demonstrate the gonococcus in the tissues of cases of decidual endometritis, and others have made similar observations. As a rule, gonorrhœal infection in the puerperium pursues a favora-



ble course, but occasionally fatal septicæmia may result, as in two of my cases reported by Harris and Dabney, and J. T. Smith.

(d) *Bacillus Coli Communis*.—In my first article upon puerperal infection (1893), it was stated that von Franqué had cultivated the colon bacillus from a case of puerperal infection, and the belief was expressed that it would be demonstrated more frequently in the future. Time has amply verified this prediction, and there are now on record a long series of cases due to this organism. *A priori*, this is what would be expected when one takes into consideration the proximity of the genital tract to the rectum, and the ease with which contamination can occur when the obstetrician fails to observe the strictest asepsis.

Some idea of the enormous numbers of colon bacilli present in the body may be gained from the figures of Vignal, which show that 1 decigram of fæces contains about 20,000,000. It is therefore evident that the examining finger can hardly avoid contamination with these organisms if it comes in contact with a non-disinfected perineum.

Gebhard demonstrated their presence in 7 cases of tympania uteri, either alone or in combination with other organisms, and Galtier states that it is the organism most frequently concerned in the production of this condition.

Ordinarily pure colon infections are very benign in character, but occasionally, as shown by Lenhartz and others, fatal septicæmia may ensue. In most serious infections the colon bacillus is associated with the streptococcus, as in cases reported by Marmorek, Charpentier, Bar and Tissier, and myself, and it appears that such a combination tends to augment the virulence of both organisms.

(e) *Bacillus Diphtheriæ*.—Formerly it was believed that the diphtheritic deposits upon the vagina and the interior of the puerperal uterus were due to the streptococcus alone, and were in no way connected with true diphtheria. That this is not always the case, however, has been shown by the observations of Nisot, Bumm, Lop, myself, and others, who have cultivated the Klebs-Loeffler bacillus from the diphtheritic membrane in the vagina, the affection yielding promptly to the use of the anti-diphtheritic serum. Gide, in 1911, was able to collect 42 such cases.

(f) *Bacillus Aerogenes Capsulatus* (Gas Bacillus).—The gas bacillus of Welch is occasionally concerned in puerperal infection. In 1896 I observed an instance of this kind, which was reported by Dobbin. Briefly stated, the case was as follows: An outdoor patient, with a generally contracted pelvis, had been in labor for three to four days under the care of a midwife. When she came into our hands she was profoundly infected and the head of a macerated child was found firmly engaged in the superior strait, the uterus being in a state of tetanic contraction. A foetid, dark-colored discharge, which contained many gas bubbles, was escaping from the vagina with a crackling sound. Delivery was effected by means of Tarnier's basiotribe. The mother died the next day, and within a few hours her body had nearly doubled its original size, as the result of the development of gas in the subcutaneous tissues. Similar changes were observed in the foetus and in the placenta, and in both we were able to demonstrate



the presence of the gas bacillus, as well as in the uterine lochia. Unfortunately no autopsy was allowed upon the mother, and we were therefore unable to say to what extent the organisms had penetrated into her tissues.

Following this, many well-authenticated instances of infection with this organism have been reported, and the entire literature upon the subject was exhaustively reviewed by Welch in 1900, Fraenkel in 1904, Heinrichius in 1908, and by Heynemann in 1911. Little, in 1905, reported ten cases in which it had been isolated in the Obstetrical Department of the Johns Hopkins Hospital, and pointed out that in all probability it was identical with the "vibrion septique" of Pasteur, as well as with the bacillus *perfringens* described by various writers. In only one of our cases did the bacillus occur in pure culture, while in all the others it was associated with other bacteria—particularly the streptococcus.

As a rule, the gas bacillus exists merely as saprophyte upon dead material, and does not invade the deeper tissues until shortly before or just after death, but in one of my patients it gave rise to a true septicæmia. Accordingly, the prognosis is usually favorable when it occurs in pure culture, but becomes very serious when it is associated with the streptococcus, as it would seem that such an association tends to augment the virulence of the latter organism. According to Welch, its presence in the puerperal uterus may give rise to emphysema of the foetus, endometritis, physometra, emphysema of the uterine wall, or gas sepsis. Moreover, it is important to remember, as was first pointed out by Welch and Dobbin, that the gas bubbles found in the blood-vessels of women supposed to have perished from "air embolism" are frequently the product of the bacillus in question. Therefore such a diagnosis is not justifiable unless careful bacteriological examination has demonstrated the absence of the gas bacillus.

(g) *Bacillus Typhosus*.—In 1898 Dobbin and I isolated *Bacillus typhosus*, *Streptococcus*, *Staphylococcus aureus*, and an unidentified anaerobic gas-producing bacillus from the uterine lochia of a Bohemian woman who was admitted to the Johns Hopkins Hospital on the fifth day of the puerperium with high fever. Her blood gave the characteristic Widal reaction, but all the usual symptoms of typhoid fever were absent. The temperature fell to normal on the thirteenth day, and did not rise again. We were inclined to believe that the bacilli were introduced into her uterus by the midwife, along with other organisms, since she was delivered upon the same bed upon which her husband had died of typhoid fever a few days previously. A somewhat similar case has been reported by Blumer, in which the autopsy revealed an unsuspected typhoid fever.

(h) *Pneumococcus*.—In rare instances this organism when introduced into the birth canal may give rise to puerperal infection, which is particularly liable to eventuate in peritonitis. Foulerton and Bonney, and Natwig have reported cases in which it was found in pure culture or associated with other bacteria.

Occasionally the presence of pneumococci in the uterine lochia is merely a manifestation of a general septicæmia originating from a focus outside of the generative tract, as in cases reported by Czernetschka, Burchhardt and others.

Still more occasionally the pneumo-bacillus of Friedländer may be isolated, as was shown by the observations of Howard, Fromme, Chirié, and others.

(i) *Bacillary Infections*.—Perkins, Charrin, and others have reported cases in which they believed that the bacillus pyocyaneus was the infectious agent. Moreover, isolated cases reported by Fraenkel, Doléris, Widal, Mixius, Goldscheider, Bumm, and others tend to show that certain cases of fatal infection may be due to bacilli with whose properties we are as yet unacquainted. But the bacteriological work upon which these statements are based is not of a character to enable us to identify the organisms in question, much less to classify them. At the same time, bacteriological examination of the uterine lochia in all cases of fever in the puerperium, as carried out by Krönig and myself, clearly show that many bacteria with which we are as yet unfamiliar may take part in the process. I have seen a case of phlegmasia alba dolens in which the infectious agent was apparently a short, thick, anaerobic bacillus.

(j) *Sapræmia*.—Besides the cases in which the infection is due to the growth and extension of micro-organisms within the body, there is a large group in which the symptoms are due to the absorption of toxins produced within the uterus by bacteria which do not invade the tissues nor make their way into the blood current. To this form of infection Matthews Duncan applied the term "*sapræmia*." It is usually thought to be due to putrefactive organisms with whose properties we are as yet almost totally unfamiliar.

No doubt the term has been greatly abused, and many cases have been included under it which were really due to infection with the ordinary pyogenic organisms. This statement has been borne out by the observations of Bumm, who found streptococci in 8 out of 11 cases which were thought to present the clinical picture of *sapræmia*. Von Franqué has obtained similar results, and concluded that *sapræmic* fever should be diagnosed only after an accurate bacteriological examination of the uterine lochia has demonstrated the absence of pathogenic and the presence of saprophytic organisms.

The causative organisms are usually anaerobic, and consequently do not grow on the usual culture media. Many of them are gas producers, and thereby cause the frothy, ill-smelling secretion which is so characteristic of these cases. Undoubtedly various bacteria may be concerned in its production, though only a few have as yet been isolated. Thus, Sackenreiter, 1912, studied 50 cases of so-called putrid endometritis with especial reference to the bacteria concerned in producing the odor associated with it. He was able to isolate the causative factor in 88 per cent. of his cases, and found the colon bacillus, an anaerobic staphylococcus—*staphylococcus parvulus*, the streptococcus putridus, an influenza-like bacillus, various unidentified anaerobic bacilli, the gas bacillus and the bacillus pyocyaneus.

Bacteriological examination of the uterine lochia in a series of 324 cases of my own, in which the temperature rose to 101° F., or higher, during the first ten days of the puerperium, gave the following results:



|                                                                         |          |
|-------------------------------------------------------------------------|----------|
| <i>Streptococcus albus</i> .....                                        | 60 cases |
| “ and <i>bacillus coli</i> .....                                        | 9 “      |
| “ “ unidentified bacilli .....                                          | 7 “      |
| “ “ <i>bacillus aerogenes capsulatus</i> .....                          | 5 “      |
| “ “ <i>gonococcus</i> .....                                             | 4 “      |
| “ “ <i>bacillus aerogenes capsulatus</i> and <i>bacillus coli</i> ..... | 3 “      |
| <i>Streptococcus</i> , anaerobic variety .....                          | 3 “      |
| “ <i>staphylococcus</i> , gas and typhoid bacillus....                  | 1 case   |
| “ “ “ “ <i>colon bacillus</i> .....                                     | 1 “      |
| <i>Staphylococcus aureus</i> .....                                      | 3 cases  |
| “ “ and gas bacillus .....                                              | 1 case   |
| “ “ “ <i>albus</i> and gas bacillus.....                                | 1 “      |
| “ <i>albus</i> .....                                                    | 5 cases  |
| <i>Bacillus coli communis</i> .....                                     | 18 “     |
| “ “ and gas bacillus .....                                              | 2 “      |
| “ “ “ <i>gonococcus</i> .....                                           | 1 case   |
| <i>Gonococcus</i> .....                                                 | 29 cases |
| “ and gas bacillus .....                                                | 1 case   |
| “ “ <i>bacillus coli</i> .....                                          | 1 “      |
| “ “ unidentified bacillus .....                                         | 1 “      |
| “ “ “ <i>coccus</i> .....                                               | 1 “      |
| <i>Bacillus aerogenes capsulatus</i> .....                              | 3 cases  |
| Unidentified anaerobic bacteria .....                                   | 22 “     |
| “ aerobic bacteria .....                                                | 6 “      |
| <i>Bacillus diphtheriæ</i> .....                                        | 1 case   |
| “ <i>typhosus</i> .....                                                 | 1 “      |
| Bacteria on cover slip, cultures negative .....                         | 63 cases |
| Sterile .....                                                           | 68 “     |
| Contaminated .....                                                      | 2 “      |

Besides the organisms already mentioned, it is not unlikely that further research will show still others which may play a part in the production of isolated cases of puerperal infection; but, to summarize, it may be said that those most commonly concerned are the well-known pyogenic organisms (*streptococcus*, *staphylococcus*, *bacillus coli*, *gonococcus*, and *pneumococcus*) and the various putrefactive varieties.

**Pathological Anatomy.**—The lesions may vary widely even in cases clinically similar, and these variations afford a probable explanation for the failure of the older authors to appreciate the true nature of the affection. Thus, there may be an almost infinite series of gradations from a slight membrane covering a small perineal tear to an inflammatory process involving the entire generative tract, or extending beyond it to the parametrium or peritoneum, and sometimes resulting in a systematic infection. In other cases the infectious elements pass through the portal of entry with such rapidity that they do not excite local lesions, but produce a *septicæmia* which is rapidly fatal—the *sepsis foudroyante* of the French authors. In the majority of cases the morbid process is limited to the endometrium, resulting in a septic or putrid endometritis, according as it has resulted from infection by pyogenic or putrefactive organisms respectively.

In other cases the lesions may be situated in any part of the generative

tract, more than one region being frequently implicated. Thus, at different times we have to deal with a puerperal vaginitis, endometritis, metritis, parametritis, metrolymphangitis, metrophlebitis, salpingitis, oophoritis, peritonitis, pyæmia, or phlegmasia alba dolens respectively.

*Lesions of the Vulva and Vagina.*—In former times the *puerperal ulcer* was of very common occurrence, but with the introduction of aseptic methods its frequency has become markedly diminished.

These ulcers appear on the surface of tears about the vulva and perineum, soon take on a dirty, greenish-yellow appearance which is due to necrosis, and are bathed in a foul-smelling secretion. In some cases they are covered by a grayish-white membrane, and on this account were formerly designated as “diphtheritic ulcers,” but usually, except for their external appearance, they have nothing in common with diphtheria. As a rule they give rise to very little systemic disturbance, and would frequently pass unnoticed were it not for ocular inspection.

*Puerperal Vaginitis.*—Of this there are two forms, the one being characterized by general inflammation, the mucosa becoming thickened, soft, reddened, and bathed with an abundant purulent secretion. In the other type, especially when torn surfaces are present, the vaginal walls may be the seat of a pseudo-diphtheritic membrane, which may vary in extent from a small patch covering a tear to a complete cast of the entire vaginal canal.

Following the recognition of the predominant rôle played by the streptococcus, it was believed for a time that none of the so-called cases of *diphtheria* of the vagina were due to invasion by the Klebs-Loeffler bacillus; but the observations of Bumm, Nisot, myself, and others show that in a few cases the latter organism is undoubtedly the ætiological factor.

*Endometritis.*—The most common lesion in puerperal infection is an inflammation of the endometrium. When one recalls the condition of the uterine cavity immediately after delivery, with its bleeding, raw surfaces and the large, gaping, thrombosed placental sinuses, it becomes apparent that pathogenic bacteria introduced during labor can easily find entry into its walls. Again, when one considers the mechanism by which the decidua is normally removed, one can readily see that an ideal culture medium is prepared by Nature for their reception and propagation.

In puerperal endometritis the infection may be limited to the placental site, or may extend over the entire mucosa. When the former alone is implicated the organisms are usually found growing into the thrombi and producing comparatively little local reaction. On the other hand, when the entire internal surface of the uterus is affected, the endometrium may become converted into a stinking, sloughing area made up of necrotic material and decidual *débris*, and bathed with a bloody, purulent discharge. The necrotic material soon takes on a dirty yellowish-green appearance, and in many instances ulcerated surfaces appear, coated with fibrin and presenting the clinical picture of diphtheria. This was formerly designated as *diphtheritic endometritis*, but, just as in the case of the vagina, the condition, as a rule, simply represents a fibrinous exudation, the result of an intense necrosis following the invasion of the usual pyogenic organisms. Infections due to the streptococcus or staphylococcus are usually associated with very



little odor; whereas in those excited by bacillus coli or any of the various putrefactive organisms the interior of the uterus is bathed with a profuse foul-smelling discharge which frequently contains gas bubbles. The amount of necrotic material produced is often enormous, and may recur with great rapidity after curetting. Fig. 661 represents the uterus from a case of



FIG. 661.—UTERUS FROM WOMAN DYING TEN DAYS AFTER LABOR FROM A MIXED INFECTION WITH STREPTOCOCCUS AND BACILLUS COLI.  $\times \frac{1}{3}$ .

puerperal infection due to streptococcus and bacillus coli. The woman succumbed ten days after the birth of the child, the uterus having been scraped clean by means of a curette three or four days previously. A glance at the drawing, however, shows that the entire cavity is filled with necrotic material, which in all probability had been reproduced in the interval elapsing between the curettage and the time of death.

Although the infection generally remains limited to the endometrium, in not a few cases it may progress beyond it, giving rise to a metritis, a lymphangitis, a phlebitis, or a peritonitis, as the case may be. This extension usually occurs through the lymphatics, and in such cases areas of inflammation can be traced along their course extending to the peritoneal surface of the uterus. At other times, especially when the infection has been limited to the placental site, the thrombi may be invaded by the micro-organisms, and there results a *phlebitis* which may remain limited to the

uterine wall, or may rapidly extend beyond it and give rise to the various thrombotic forms of puerperal infection.

The lesions produced in the endometrium vary considerably according to the micro-organisms concerned, and still more according to their virulence. When the infection is due to a virulent streptococcus or staphylococcus, the local changes are comparatively slight, the process rapidly spreading through the lymphatics or veins past the uterus, and giving rise to a peritonitis or a general systemic infection. On the other hand, in the cases due to putrefactive organisms, to the colon bacillus, and to the ordinary pus-organisms of lesser virulence, the process remains more or less



FIG. 662.—UTERUS FROM WOMAN DYING TEN DAYS AFTER LABOR FROM STREPTOCOCCUS INFECTION.  $\times \frac{3}{4}$ .

limited to the endometrium and causes marked local lesions. Fig. 662 represents the uterus from a woman dying of a virulent streptococcic infection. The walls of its cavity are seen to be almost perfectly smooth, and nothing is present which could have been removed by means of the curette. In this respect the case stands in marked contrast to the one represented in



Fig. 661, in which the infectious agents were streptococcus and bacillus coli.

Moreover, upon studying the microscopical features of puerperal endometritis, one finds these differences still further accentuated. Our original knowledge on this point we owe to the researches of Bumm and Döderlein, both of whom have shown that there are marked histological differences between the putrid and septic forms. According to Bumm, in sections through the wall of a uterus the seat of a *putrid endometritis*, a thick layer of necrotic material is found lining the uterine cavity, embedded in which are large numbers of the offending micro-organisms. Beneath this is a thick layer of leukocytic infiltration—the zone of reaction—and, under this again, more or less normal tissue. Careful study shows that the micro-organisms are limited almost entirely to the superficial necrotic layer; and although a few may be present in the reaction zone, none can be made out in the tissues beneath it, thus showing Nature's mode of preventing the invasion of the body (Figs. 663 and 665).



FIG. 663.—PUERPERAL ENDOMETRITIS DUE TO COLON INFECTION, SHOWING MARKED DEVELOPMENT OF LEUKOCYTIC WALL.



FIG. 664.—PUERPERAL ENDOMETRITIS DUE TO STREPTOCOCCUS INFECTION, SHOWING SLIGHT DEVELOPMENT OF LEUKOCYTIC WALL.

Similar pictures are also observed in the cases due to infection with pyogenic organisms possessing only a slight degree of virulence. On the other hand, in *septic endometritis*, and especially when the organisms are virulent, a totally different appearance is noted. Although a layer of necrotic material containing organisms is likewise found adjoining the

PLATE XVI.



K.M. Montague, fec

SECTION THROUGH ENDOMETRIUM IN STREPTOCOCCIC PUERPERAL  
INFECTION.  $\times 1000$ .



rapidly spreads to the surrounding connective tissue and eventuates in abscess formation. In more severe cases the inflammatory process follows the course of the lymphatics, and sometimes spreads behind the peritoneum, giving rise to *retroperitoneal phlegmons*, which may extend as high as the posterior mediastinum. On the other hand, the abscess formation may dissect the peritoneum off from the anterior pelvic and abdominal wall, and eventually point over Poupart's ligament. In still another class of cases the bacteria follow the lymphatics in the connective tissue surrounding the greater vessels of the thigh, and give rise to a rare form of phlegmasia alba dolens, the usual variety being due to the extension of a thrombotic process originating in the uterine veins.

As has already been pointed out, in a considerable number of cases the inflammatory process extends into the uterine wall, and there gives rise to divers lesions of *metritis*, which may vary from small areas of leukocytic infiltration to definite abscess formation. As multiple abscesses are due to implication of the lymphatics, and, inasmuch as these channels are most numerous beneath the peritoneal covering of the uterus, such lesions are most abundant in that situation.

Under the designation *metritis dessicans*, Garrigues described a variety of severe puerperal infection in which not only the endometrium, but also a varying amount of the muscularis undergoes necrosis, and is expelled in large shreds or even as a cast of the interior of the uterus. As Schmid-lechner suggests, it should more properly be designated as gangrene of the uterus.

*Salpingitis*.—In a small proportion of cases the infectious process extends directly from the uterine cavity to the Fallopian tubes, and there gives rise to various inflammatory phenomena. Occasionally the salpingitis is due to infection through the lymphatics and not by continuity from the endometrium. In many instances, however, the tubes are not involved, and when they are the lesions are more marked at the lateral than at the uterine end, thus indicating that in many cases the infection is secondary to the peritoneal involvement. Sometimes an *oophoritis* occurs, the ovaries being enlarged to several times their usual size and very oedematous. The process may stop here or go on to typical abscess formation. The ovarian infection is usually due to lymphatic involvement, and may be associated with affections of the parametrium. Much more rarely it results from direct infection of a ruptured follicle by means of the peritoneal fluid.

*Peritonitis*.—In the vast majority of cases the fatal termination in puerperal infection is due to a peritonitis. As was pointed out when considering the histological changes in puerperal endometritis, the streptococci or other infecting agents may rapidly make their way by means of the lymphatics from the interior of the uterus to the peritoneal surface and there give rise to inflammatory changes. This is the usual mode of infection, but in rare instances it may be due to the escape of pus from the Fallopian tubes; though in none of the autopsies which I have witnessed upon women dead of puerperal fever has such a mode of origin been observed, while in many instances the tubes are not implicated, or the process is limited entirely to their lateral ends. Occasionally, it may follow the rupture of a



uterine cavity, it is usually thinner than in the preceding case. The zone of leukocytic infiltration is either lacking or very imperfectly developed, and the micro-organisms can be observed making their way down through the decidua and along the lymphatics of the muscular wall of the uterus out toward its peritoneal surface (Figs. 664 and 666). I have been able to



FIG. 665.—COLON BACILLUS ENDOMETRITIS. LEUKOCYTIC WALL NOT INVADDED BY BACTERIA.  $\times 800$ .



FIG. 666.—STREPTOCOCCUS ENDOMETRITIS, SHOWING INVASION OF LEUKOCYTIC WALL  $\times 800$ .

confirm abundantly the observations of Bumm, whose conclusions are amply justified (Plate XVI).

It would appear, therefore, that Nature endeavors to confine the micro-organisms to the inner surface of the uterus by interposing between the necrotic layer and the deeper portions a barrier of leukocytic infiltration, which acts as an efficient filter when the micro-organisms are attenuated, but fails to restrain them when they possess a marked degree of virulence.

*Parametritis.*—One of the more frequent complications of uterine infection is parametritis. This frequently follows infected tears of the cervix, but in other cases is secondary to a typical puerperal endometritis; in either event it is due to the transmission of the micro-organisms through the lymphatics to the peri-uterine connective tissue. The first effect of their invasion is a marked inflammatory œdema, with very little or no suppuration. In mild cases the process goes no further, but in the severer types it



rapidly spreads to the surrounding connective tissue and eventuates in abscess formation. In more severe cases the inflammatory process follows the course of the lymphatics, and sometimes spreads behind the peritoneum, giving rise to *retroperitoneal phlegmons*, which may extend as high as the posterior mediastinum. On the other hand, the abscess formation may dissect the peritoneum off from the anterior pelvic and abdominal wall, and eventually point over Poupart's ligament. In still another class of cases the bacteria follow the lymphatics in the connective tissue surrounding the greater vessels of the thigh, and give rise to a rare form of phlegmasia alba dolens, the usual variety being due to the extension of a thrombotic process originating in the uterine veins.

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parametritic or ovarian abscess, while in other cases it may result from instrumental perforation of the uterus or vaginal *cul-de-sac* during criminal abortion.

*Pyæmia*.—The pyæmic form usually results from the infection of thrombi at the placental site and subsequent inflammatory changes occurring in the veins. The thrombosis may be limited to a comparatively small area and be entirely within the uterine wall, or it may extend beyond the uterus, so that occasionally all the pelvic vessels are thrombosed as far up as the junction of the renal veins with the inferior vena cava. Its mode of production was exhaustively studied by Bardeleben in 1907. By the breaking down of the thrombi small particles escape into the circulation and are carried by the blood current in various directions, giving rise to endocarditis and *metastatic abscesses*, from which no portion of the body appears to be exempt. In this form of puerperal infection, such abscesses may be found in any of the internal organs, the synovial surfaces also being frequently implicated and giving rise to swellings about the joints, which, if not promptly treated, may lead to their complete destruction. In other cases blebs or *bullæ*, due to the same cause, appear on various portions of the body, and in their contents the offending micro-organisms are readily demonstrable.



FIG. 667.—SECTION THROUGH THROMBOSSED PELVIC VEIN, SHOWING STREPTOCOCCI.  $\times 800$ .

Less frequently, detached particles of thrombi may be arrested in one of the larger vessels of the lungs and give rise to pulmonary embolism and almost instantaneous death. When smaller vessels are involved the results are not so serious, though the portion of lung supplied by them becomes infarcted and gives rise to a secondary pleurisy or pneumonia, which may ultimately lead to death. It would appear from the observations of Mahler, Breuer, and Richter that a large part of the pulmonary affections occurring in puerperal women originate in this manner, and in not a few instances the appearance of a localized pleurisy may be the first manifestation of a serious thrombotic process. Most cases of pyæmia present very little uterine involvement, and death, when it occurs, is due to general exhaustion following a prolonged suppurative process, rather than to peritonitis, which is the usual cause of death in the other forms of infection.

*Phlegmasia Alba Dolens*.—As was pointed out when the question of parametritis was considered, this affection is sometimes due to the extension through the lymphatics of a parametritic process to the tissues surrounding the great vessels of the thigh. As a rule, however, it results from the extension of a thrombotic process from the pelvic veins; and in several of my



autopsy cases the thrombo-phlebitis could be traced from the uterus to the internal and common iliac veins, whence it extended upward to the vena cava and downward through the external iliac to the vessels of the foot.

Occasionally, in cases which recover, the phlegmasia appears to be an isolated process, though it is probably only a part of a much more extensive thrombosis. Moreover, it should be borne in mind that even widespread thrombosis may give rise to but slight clinical manifestations, as in one of my cases, in which at autopsy the femoral vein and all its branches were completely occluded, though careful mensuration was necessary to detect any difference in the size of the legs.

Clinically phlegmasia alba dolens should always be regarded as a manifestation of infection; although it may possibly be of other origin. Thus, my assistant, F. C. Goldsborough, described a case of complete occlusion of the common iliac, external iliac, and femoral veins, which was clearly the result of pressure. Such an inference, however, is not permissible unless the case comes to autopsy, and careful bacteriological examination demonstrates the absence of bacteria.

An excellent idea of the frequency of the various lesions in fatal cases of puerperal infection may be gained from the statement of Kneise, who studied the autopsy reports from 89 cases in Halle, with the following results:

|                          |          |
|--------------------------|----------|
| Peritonitis .....        | 43 cases |
| Thrombo-phlebitis .....  | 20 "     |
| Pyæmia .....             | 17 "     |
| Parametritis .....       | 7 "      |
| Sepsis foudroyante ..... | 2 "      |

✓ **Etiology.**—As it has been conclusively demonstrated that the bacteria concerned in puerperal infection are identical with those with which we are familiar as causing wound infection, it must follow that puerperal infection is a wound infection resulting from the introduction of pyogenic organisms into the generative tract either before, during, or immediately after labor. In other words, it is usually a direct infection from without, the offending bacteria being brought to the woman by the hands, instruments, or any other object which may come in contact with her generative organs.

Puerperal infection, then, is *contact infection*, this conception having been first definitely enunciated by Semmelweis in the following words: "I consider puerperal fever, not a single case excepted, as a resorption fever, caused by the resorption of a decomposed animal-organic material. The first result of the absorption is a change in the blood, and the exudations are the result of this change. The decomposed animal-organic material, which, when resorbed, causes childbed fever, is brought to the individual from without in the great majority of cases, and this is infection from without. These are the cases which represent the epidemics of childbed fever. These are the cases which can be prevented."

In the latter part of the eighteenth century puerperal fever began to be considered as a contagious malady in England. This conception apparently originated with Thomas Kirkland, of Ashby, in 1774, but was first

clearly enunciated in 1795 by Gordon, of Aberdeen, in his treatise "On the Epidemic of Puerperal Fever, as it prevailed in Aberdeen from December, 1789, to March, 1792." In this he gave an account of 77 cases which he had attended, and, among other things, stated: "It is a disagreeable declaration for me to mention that I myself was the means of carrying the infection to a great number of women."

In this country we are mainly indebted to Oliver Wendell Holmes for introducing the conception of the infectious nature of the affection. In an article entitled Puerperal Fever as a Private Pestilence, first published in 1843, he clearly showed that the epidemic form of the disease was preventable, and owed its origin either to the accoucheur or midwife. His teachings, however, did not exert the influence which might have been expected, mainly because they were opposed by the leading obstetricians of the country, notably Meigs and Hodge, the former stating that he preferred to consider the disease as due to the workings of Providence, which he could understand, rather than to an unknown infection of which he could form no conception.

For many years the prevalent theory in Europe was that puerperal fever was due to miasmatic, telluric, or atmospheric influences. This view held its ground for years after the appearance of Semmelweiss's book in 1861; although in 1864, Hirsch, after studying the matter from an historical standpoint, came to the conclusion that the malady was of infectious rather than of miasmatic origin.

It was not, however, until after Lister had introduced antiseptic methods into surgery, and Stadfeld, of Copenhagen, had recommended the use of bichloride of mercury in obstetrics, that the great mass of the profession began to understand that puerperal fever was due to contact infection, and could be prevented to a very great degree. The bacteriological work of Pasteur and his successors, and the almost constant presence of streptococci in fatal cases, decided the question, and at present no one doubts the infectious nature of the disease.

*Modes of External Infection.*—The most usual mode of infection is by the hands of the obstetrician or the midwife, and no one who has observed the way in which many medical men conduct labors can wonder that puerperal fever occasionally occurs. The employment of dirty instruments, as well as of dirty hands, also plays an important part.

Sources of infection, much rarer, it is true, but generally overlooked, especially among the lower classes, are self-inoculation by the patient fingering her genitalia or even making internal examinations and copulation during the latter days of pregnancy. Liepmann states that bacteriological examination of the prepuce of the penis reveals the presence of streptococci in 75 per cent. of all cases; while I have seen two out-patients die, who had not been examined internally; but upon seeking an explanation for the infection, I found that they had copulated during the first stage of labor. Contact with secretions from wounds of any kind also plays an important part, and whether the purulent material be from an external wound or elsewhere within the body, the result will be the same. It is only necessary to recall in this connection the case of Dr. Rutter, of Philadelphia, who was



## PUERPERAL INFECTION

... an emblem of puerperal fever, while his ... from it. It appeared later that ... from which he was constantly con- ... of the hands of the physician or nurse, bone ... and not infrequently a pustular

... known that puerperal fever often occurred ... by a physician who at the same ... As has already been said, some of ... affections were identical, but it was not ... that erysipelas and most serious cases of puer- ... streptococcus that this relation was under- ... generally believed that there is no essential ... erysipelas of Fehleisen and the or-

... frequently observed to occur in the prac- ... scarlet fever, and occasionally typhoid ... relationship between these affections has ... that in both diphtheria and scarlet fever ... are frequently met with, and these ... the woman in labor.

... some to play an important aetiological part, ... the external genitalia with an occlusive ... into the vagina, and thus eliminate this ... however, occurs very rarely, if, indeed, it is ... Nevertheless, in England, and to a less ... is believed to play a prominent part in its ... that the danger of infection from such sources ... and will be spoken of less and less frequently ... versed in vigorous aseptic technique.

... conception Semmelweiss possessed of the vari- ... it may be interesting to quote what he ... of the decomposed animal-organic mate- ... the operating hand, instruments, bedclothes, ... the hands of midwives or nurses which come in

... of women sick with puerperal fever, and after- ... parturient women. In other words, the bearer of ... organic material is anything which is soiled by a ... material and comes in contact with the genitalia

... one at the present time believes that the vast ... of puerperal infection are the result of the intro- ... pathogenic micro-organisms into the genital canal ... woman. Nevertheless, many authorities teach ... cases the infection does not result in this man- ... micro-organisms which were already within the ... of labor. To infection arising in this way the ... The conception originated with Semmel-

In the latter pe- ... be considered as a ... ently originated with

### Aetiology

concerns ... familiar ... is a woman ... isms intro- ... labor. In ... offending ... or any other

Puerperal ... been first de- ... "I consider p- ... fever, caused by ... The first result- ... tions are the re- ... terial, which, wh- ... vidual from with- ... from without. Th- ... bed fever. These

weiss, who stated: "In rare cases the decomposed animal-organic material, which causes childbed fever when absorbed, is produced within the patient herself. These are the cases of auto-infection, and cannot be prevented."

With the enthusiasm which attended the introduction of antiseptic methods of midwifery, the possibility of auto-infection was lost sight of for a time, and it was only after the statistics of well-conducted lying-in establishments showed that a certain number of cases of infection still occurred, despite the rigorous application of antiseptic principles, that the idea was rehabilitated by Ahlfeld and Kaltenbach (1883-1889).

Of course, with the recognition of the fact that puerperal fever was a bacterial disease, the definition introduced by Semmelweis fell to the ground, since the micro-organisms could not originate spontaneously within the body of the woman. Kaltenbach then advanced the view that pathogenic bacteria are normally present in the vagina of a considerable number of healthy pregnant women, and that these might make their way into the uterus, or be introduced into it, by the sterile examining finger. Most observers now hold that auto-infection, even in this modified sense, is not possible, and that all cases of puerperal infection are due to the introduction from without of pathogenic micro-organisms at the time of labor.

Apparent proof of the possibility of the occurrence of auto-infection is afforded by the rare instances of serious puerperal infection in women who had not been examined vaginally, and whose labors had been conducted in a thoroughly aseptic manner. Such cases undoubtedly sometimes occur, but even in them the proof is not absolute; as it is impossible to prove that the women may not have infected themselves by handling the genitalia, or that the bacteria were not derived from a suppuration focus within the body, or were not brought to the uterus by means of the blood current.

Winter, in 1911, admitted the justice of these contentions, and held that one is justified in speaking of auto-infection only when careful bacteriological examination can demonstrate that the bacteria found in the puerperal uterus had existed in the vagina at the onset of labor. He considers that he has been able to adduce such proof, and therefore holds that auto-infection undoubtedly occurs. Accordingly, the question can be finally decided only by the results of the bacteriological examination of the generative tract in the pregnant condition. Unfortunately, the investigations which have been undertaken in the hope of settling the question have not given uniform results, and consequently we are nearly as far from a scientific solution of the problem as when it was first broached; although in actual practice a constantly increasing number of obstetricians act as if the possibility of auto-infection had been definitely disproved.

Practically all investigators are united in claiming that the cavity of the normal uterus is free from micro-organisms both in the pregnant and non-pregnant condition. This fact has been amply demonstrated by the work of Gönner, Döderlein, and Winternitz in women, and by Strauss, Sanchez-Toledo, and Denzler in the lower animals.

Prior to 1898 it was generally believed that the cavity of the normal puerperal uterus was free from bacteria, and that their presence afforded indubitable evidence of infection. In that year, however, Franz stated



that bacteria could frequently be found after the first few days of the puerperium in women who had presented no clinical signs of infection. His results were soon confirmed by Burckhardt, and promptly denied by Döderlein and Winternitz. At first it was believed that the bacteria in question were merely saprophytes, but other investigators, such as Stolz, Schenk, and Scheib, found streptococci in from 30 to 38 per cent. of their cases. On the other hand, Foulerton and Bonney, Brownlee, and others stated that streptococci were never present in the normal puerperal uterus.

In view of these contradictory statements, my former assistant, H. M. Little, investigated the question. For this purpose he studied the uterine lochia obtained from 50 consecutive women delivered in my clinic in 1904. In each case cultures were taken immediately after the expulsion of the placenta, and again on the third and ninth days of the puerperium. Not counting the gonococcus, the uterus was found to be sterile in 96, 85, and 70 per cent. of the cases on the three days respectively, and in none of the 150 examinations were streptococci found.

These observations, therefore, clearly indicate that the normal puerperal uterus at no time contains the usual pyogenic bacteria; but, on the other hand, it cannot be regarded as sterile except immediately after delivery, and becomes progressively more and more contaminated as the puerperium advances. The bacteria present are usually saprophytic in character, and while they may give rise to slight febrile disturbances they cannot be held responsible for the production of the grave forms of infection.

As our investigations, contrary to those of many German authorities, show that the normal puerperal uterus does not contain streptococci, the question as to the possibility of auto-infection must stand or fall with the demonstration of such bacteria in the vaginal secretion of healthy pregnant women. If they are even occasionally present it must be admitted that they may be carried up into the uterus by the sterile examining finger, and give rise to infection; whereas if they cannot be demonstrated, such a contention must be dismissed as unfounded.

The vaginal secretion during pregnancy always contains large numbers of bacteria, mostly bacillary in character, although cocci are frequently seen. Unfortunately, the bacteriological investigations which have been undertaken to determine the nature of the latter have served rather to complicate than to settle the question; one set of observers claiming that streptococci are frequently present, and the other contending that, with the exception of the gonococcus, pyogenic bacteria are always lacking.

The studies of Döderlein, published in 1892, promised for a time to reconcile the conflicting results, but as they have not been confirmed by subsequent investigators, the question still remains an open one. He stated that the vaginal secretion might occur in one of two forms, which he designated as normal and pathological. The former was a thick, dry, cheese-like material of a whitish color and a distinctly acid reaction. Microscopically it showed epithelial cells, a pure culture of tolerably long, thin bacilli, and occasionally a few yeast fungi. The pathological secretion, on the other hand, was fluid, generally of a yellowish color, suggesting pus, and sometimes contained gas bubbles. Its reaction was less acid than that of the

normal secretion, occasionally neutral, and very rarely even alkaline. In it were found large numbers of leukocytes and many micro-organisms of various kinds, both bacilli and cocci. Fifty-five per cent. of his patients presented a normal and 45 per cent. a pathological secretion. As pyogenic bacteria were never present in the former, while streptococci were noted in 10 per cent. of the latter, he held that auto-infection was out of the question when the secretion was normal, but might occasionally occur when it was pathological.

The following table gives an idea of the frequency with which streptococci have been demonstrated in the vaginal secretion by certain investigators:

|                  |       |                       |      |
|------------------|-------|-----------------------|------|
| Burekhardt ..... | 4%    | Winter .....          | 15%  |
| Steffeck .....   | 4%    | Williams (1893) ..... | 20%  |
| Döderlein .....  | 4.1%  | Vahle .....           | 25%  |
| Burguburu .....  | 8.5%  | Walther .....         | 27%  |
| Koblanek .....   | 9.5%  | Stolz .....           | 30%  |
| Vahle .....      | 10%   | Bumm and Sigwart ..   | 74%  |
| Witte .....      | 12.5% | Natwig .....          | 100% |
| Kottmann .....   | 13%   |                       |      |

This great disparity would seem to indicate that some of the investigators, at least, were in error, as it is scarcely conceivable that streptococci could occur 25 times more frequently in one set of women than in another. Moreover, if they occur as frequently as some observers state, it would appear remarkable that relatively so few patients suffer from streptococcic infection. To overcome this objection it was assumed by some that the vaginal streptococci were of a different strain from those which give rise to severe infections, or at least possessed only a very slight degree of virulence. The comparison of the biological characteristics of such streptococci with those derived from infectious processes, however, failed to sustain such a contention. Accordingly, Walther and Reber attempted to escape from the dilemma by assuming that the women became immune to the action of their own streptococci, and therefore could be infected only by those coming from an extraneous source. This appears to me to be a *reductio ad absurdum*, and it would seem far more probable that the explanation for the high percentage of streptococci is to be sought in some error of technique.

On the other hand, Krönig, in 1897, stated that in the vaginal secretion of 167 pregnant women he had been unable to demonstrate the presence of typical streptococci or any other pyogenic bacteria, with the exception of the gonococcus. Moreover, he showed that the secretion was decidedly antagonistic to streptococci introduced from without, all trace of them usually disappearing in the course of twelve hours. He therefore concluded that it should be considered as practically sterile, and that there was not the slightest evidence in the support of the doctrine of auto-infection.

In 1898 I confirmed Krönig's findings, when I reported to the American Gynecological Society that I had been unable to demonstrate the presence of the streptococcus or staphylococcus aureus in the vaginal secretion of 92 pregnant women. In view of this fact I concluded that auto-infection from these micro-organisms was impossible, and when they were dem-



onstrated in the puerperal uterus, that they had been introduced from without. At the same time I admitted that certain cases of puerperal endometritis might occasionally be due to auto-infection by other bacteria.

These conclusions were absolutely contradictory to those at which I had arrived five years previously, when I found streptococci in 20 per cent. of my cases. In the two series of observations the work was conducted under identically the same conditions, except that in the first the secretion was obtained by means of a sterile glass speculum, whereas in the second Menge's tube was employed, which could be introduced without coming in contact with the margins of the hymen. The conclusion, therefore, appeared inevitable that in the first series bacteria from the margins of the hymen or the inner surfaces of the labia minora had been carried into the vagina by the speculum; whereas, such contact having been avoided in the second series, the secretion obtained was absolutely free from contamination.

The correctness of this explanation was placed beyond all reasonable doubt by the examination of 25 additional cases, 3 sets of cultures being made from each. The first was taken from the inner surface of the labia minora, the second from the vaginal secretion obtained by means of a Menge tube, and the third from the vaginal secretion obtained through a sterilized speculum. Pyogenic cocci or colon bacilli were demonstrated in 80 per cent. of the first, in none of the second, and in 48 per cent. of the third set of cultures, thereby indicating that the vaginal secretion of healthy women is free from pyogenic cocci, when obtained without contamination, but that since bacteria are usually present upon the hymen and labia minora, it is impossible to introduce a speculum into the vagina without carrying them along with it, in at least one half of such cases.

This explanation apparently settled the matter for a few years, but in 1904 Bumm and Sigwart stated that it was not satisfactory, and that my negative results were to be attributed to the employment of unsuitable culture media, so that streptococci escaped detection. They then reported the results obtained in the examination of the vaginal secretion of 103 pregnant women. Menge's tube was not employed, but instead a speculum was introduced and the secretion obtained from a portion of the vaginal wall, which presumably had not come in contact with it, and then inoculated into bouillon. Streptococci were demonstrated in from 38 to 74 per cent. of their cases, according as cultures were taken upon one or several occasions.

These results were at such variance with my own that my assistant, John M. Bergland, in 1906, repeated Bumm's experiments, employing exactly the same technique and culture media. For this purpose cultures were taken from 50 consecutive normal pregnant women, as follows:

1. From the vulva before disinfection.
2. From the vagina by means of Menge's tube.
3. From the vagina by means of a speculum, following Bumm's technique. In each group cultures were made in sugar bouillon, following Bumm's recommendation, as well as upon solid media.

In group 1 the cultures were nearly always positive, in group 2 always positive, and in group 3 as far as pyogenic cocci were concerned, while in group 3 positive

results were obtained in more than one half of the cases in which bacteria had been demonstrated upon the vulva.

These observations confirmed *in toto* my previous work, and demonstrated conclusively to my mind that the vaginal secretion, when properly obtained, is sterile so far as pyogenic bacteria are concerned, and also that a speculum cannot be introduced into the vagina except at a considerable risk of carrying up bacteria from the vulva.

It is important to note that even when Bergland obtained positive results streptococci were found but rarely, their place being taken by staphylococci and colon bacilli. It would, therefore, be interesting to find an explanation for this difference, as it is impossible to believe that so competent bacteriologists as Bumm and Sigwart could have confounded other bacteria with streptococci; while at the same time it is hardly probable that the bacterial flora of the vulva could vary so greatly in Baltimore from that observed in Berlin and Halle.

Unfortunately for our peace of mind, Krönig and Pankow, in 1908, again took up the subject, and in a series of 52 examinations found no streptococci in the vaginal secretion when agar plates were used, but demonstrated them in 17.3 per cent. of the cases when weak alkaline grape-sugar bouillon was employed. I have not repeated this work, but expect to do so in the near future.

In the meantime, however, as a result of our own work, I hold that pyogenic cocci are not normally present in the vaginal secretion of pregnant women. Consequently, whenever they are demonstrated in the uterine lochia of puerperal women, they should be regarded as distinct evidence of external infection. At the same time it is possible in rare instances that auto-infection may occur from other organisms, which are found in the vaginal secretion, and plausibility is lent to such a supposition by the increasing frequency with which bacteria are found in the uterus with the advance of the puerperium; but satisfactory evidence cannot be adduced in support of such an occurrence until methods have been devised which will enable us to isolate and cultivate in pure culture the organisms in question, many of which are anaerobes which will not grow upon the usual media.

The gonococcus forms an exception in this regard, as it is the only pyogenic coccus which can live and thrive in the vaginal secretion. As already indicated, it is frequently the cause of an elevation of temperature during the puerperium. Such cases, however, should not be considered as supporting the doctrine of auto-infection, for the reason that the women were infected before conception or in the first few months of pregnancy, after which the gonococci persist in the crypts of the cervical canal, where they live as parasites, and simply find more suitable conditions for development in the first few days of the puerperium, when they make their way up into the uterine cavity and manifest their presence by the production of fever and an increased discharge.

Likewise, one should not regard as auto-infection, in the strict sense of the word, those cases in which the bacteria are brought to the uterus from distant foci of disease by means of the blood current, nor those in



which the process results from some pre-existing affection of the generative tract, such as an old pyosalpinx.

An interesting fact in connection with the question of auto-infection is that those who believe most firmly in its possibility, and who are in the habit of employing a prophylactic vaginal douche for the destruction of the vaginal bacteria, have thus far been able to present less favorable statistics than their opponents. Thus, Ahlfeld found that after its use 38 per cent. of his patients had a rise of temperature during the puerperium. Again, Kaltenbach, while chief of the Lying-in Clinic at Halle, always resorted to its routine employment, but the statistics showed a very material improvement after his successor, Fehling, discontinued the practice. Furthermore, the results of Leopold and Mermann, who did not use the douche at all, showed a constant improvement corresponding with the increasing precision with which objective asepsis was carried out.

**Frequency.**—It is very difficult to make accurate statements as to the frequency of puerperal infection, especially when it occurs outside of hospital practice. Concerning this condition the vital statistics of the health offices of the various American cities are of no value, inasmuch as the vast majority of deaths from this disease are returned as being due to malaria, typhoid fever, pneumonia, or other causes.

Since the introduction of antiseptic methods into midwifery the mortality from puerperal infection has decreased very markedly in hospital practice. Formerly, in the old Maternity of Paris, and in the Lying-in Hospital in Vienna, it varied from 10 to 15 per cent., so that finally it attracted the attention of the public at large, and steps were being taken to abolish such institutions as a menace to public health. With the introduction of aseptic methods, however, all this was changed, so that at present in well-regulated lying-in hospitals the mortality from infection is usually only a small fraction of 1 per cent., Pinard, in 1909, having reported a mortality of 0.15 per cent. in 45,633 deliveries. Hence it happens that at the present time, in the discussions upon the subject, so far as hospitals are concerned, the question is rather one of morbidity than of mortality, and deals with the percentage of patients whose temperature rises above 38° C. or 100.4° F. during the puerperium.

On the other hand, in private practice it is doubtful whether the results are materially better to-day than they were before the introduction of antiseptic methods, for the reason that the doctrines of asepsis have not yet permeated the rank and file of medical men, much less of midwives, to whose care is committed a very large proportion of obstetrical cases. Though, at the same time, it must be admitted that we rarely hear of outbreaks of puerperal infection such as are mentioned in the historical work of Hirsch, who gives the particulars of 216 epidemics occurring between the years 1652 and 1862.

Boehr stated in 1875 that 363,324 women had died from puerperal infection in Prussia during the preceding 60 years, and calculated that every thirtieth married woman eventually perished from it; while Ehlers contended that outside of the well-regulated hospitals the results were equally

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bad in 1900. Furthermore, Fromme stated, in 1910, that at least 5,000 women succumb each year in Prussia to this preventable malady.

Bacon, in an article based upon the records of the health department of Chicago, showed that for the forty years prior to 1896 puerperal infection was assigned as the cause of death in 12.75 per cent. of the women dying between the ages of twenty and fifty years, varying between 20 per cent. in 1873 and 7.3 per cent. in 1895. Similar results were reported by Ingerslev, who stated that, even at the present time in Denmark, with the single exception of tuberculosis, puerperal infection is the most frequent cause of death in women during the childbearing period.

The investigations of Boxall, Byers, and Lea show a similar condition in England, where it may be said that outside of the lying-in hospitals this preventable scourge claims as many and perhaps more victims than it did twenty or even forty years ago.

Moreover, in trying to determine the frequency of puerperal infection, one cannot be guided altogether by the mortality statistics, inasmuch as the largest proportion of these cases do not end fatally. On the other hand, any one who deals much with gynecological patients cannot fail to be impressed with the very large proportion whose troubles have originated from febrile affections during the puerperium, which in many instances were clearly due to the neglect of aseptic precautions on the part of the obstetrician or midwife.

**Symptoms.**—As was stated when considering the pathological anatomy of puerperal infection, the common lesion is an endometritis. This may be either of the septic or putrid variety, each type presenting a group of more or less characteristic symptoms.

In the case of septic endometritis, after everything has gone smoothly for the first three or four days of the puerperium, the patient suddenly experiences some malaise, and complains of headache and a feeling of chilliness, or she may have a well-defined chill, the temperature rising to 103° F. or higher. Generally, only one rigor occurs, after which the temperature remains constantly elevated. At the same time there is some tenderness in the lower part of the abdomen, the uterus is larger and more doughy in consistency than it should be, and is sensitive on pressure. The lochial discharge is sometimes increased in quantity, and is partly bloody, partly purulent in character, although in the purely septic forms it is practically devoid of odor. If the temperature is very high the secretion is frequently diminished in amount, and occasionally disappears almost entirely.

The character of the uterine discharges in these cases often leads to a mistake in diagnosis, for the average practitioner associates puerperal infection with profuse and foul-smelling lochia; whereas, in reality in the more virulent cases of streptococcus infection, there is very little, if any, odor, and its absence, therefore, is not necessarily a favorable indication, but rather the reverse.

Another point of importance is the faulty involution of the uterus. This must be looked upon as an important factor in the further spread of the disease, for the micro-organisms make their way through the muscular



walls of the uterus by means of the lymphatics, and when the organ is markedly relaxed these channels are more patent and offer far less resistance to the outward passage of the bacteria than when firm, normal contraction is present.

The further history of septic endometritis varies according as the process remains limited to the cavity of the uterus or extends beyond it. In the former case the temperature gradually falls, the secretion becomes less and less, and the patient is slowly restored to health. The mucosa, however, is not restored to its normal condition at once, but for a long time remains the seat of a subacute or chronic inflammation. When the process has extended beyond the uterus the symptoms will vary according to the organs involved, and those belonging to a parametritis, peritonitis, or pyæmia, as the case may be, are superadded.

In putrid endometritis we likewise have the initial chill and the high temperature, but the patient's condition does not usually appear so serious as in the septic form. The main difference, however, is to be noted in the character of the uterine discharge, which, in the putrid cases, is abundant, very foul-smelling, and frequently has a frothy appearance. These cases usually eventuate in recovery, and only rarely terminate fatally.

Between these two well-marked classes of cases, however, there exist all gradations, and not uncommonly we have to deal with a mixed infection due to pyogenic as well as putrefactive organisms.

As has already been said, the chill and rise of temperature are occasionally associated with localized ulceration about the vulva or somewhere in the vagina. In the vast majority of cases, however, the puerperal ulcer or vaginitis does not occur alone, but is accompanied by an endometritis.

The extension of the process from the uterine cavity or from ulcers about the cervix to the parametrium produces an array of more or less characteristic manifestations. In many cases the initial rise of temperature lasts only for a short time, and we are congratulating ourselves that our patient has escaped so easily when suddenly another chill occurs, the fever rises again, to pursue a more or less irregular course, usually marked by evening exacerbations. Within a few days vaginal examination or abdominal palpation will reveal the presence of a mass on one or both sides of the uterus, due to pus formation within the folds of the broad ligament. The abscess may be limited to the broad ligament itself, or may extend along the connective tissue upon the anterior portion of the pelvis up to the neighborhood of Poupart's ligament; in other cases, again, it extends backward toward the retroperitoneal region. The fever continues until the abscess has been opened or ruptures spontaneously, except in the few instances in which it undergoes gradual resorption, leaving a mass of cicatricial tissue to mark its former situation. If not operated upon, a parametritic abscess may burst spontaneously into the rectum or bladder, and occasionally through the abdominal wall in the region of the inguinal canal. Unless it ruptures into the peritoneal cavity the patient usually recovers with proper care.

In certain instances the infection extends from the uterine cavity to the Fallopian tubes, and there gives rise to a salpingitis with its accom-

panying symptoms. A large proportion of the cases of pyosalpinx, particularly those following abortions, which come to operation months or years later, have originated in this manner.

Unfortunately, it frequently happens that the process does not remain limited to the uterus or to the parametrium, but the micro-organisms make their way through the lymphatics of the muscular wall of the uterus to the peritoneum, and there excite a *peritonitis*; though in exceptional instances the latter may result from an extension of the inflammation from the tubes, and occasionally from the rupture of a parametritic, ovarian, or tubal abscess.

Somewhat rarely the peritoneal implication is limited to the portion lining the pelvic cavity—pelvic peritonitis. If the process does not spread the chances are that the patient will recover, but if the peritonitis becomes generalized death is almost inevitable. The characteristic symptoms of peritonitis usually make their appearance during the first week of the puerperium, but rarely before the third or fourth day. If they occur at a later period the process is usually due to the rupture of an abscess.

When very virulent streptococci are the infecting agents the endometritic implication is usually very slight, and practically the first sign of infection appears from the side of the peritoneum. A marked rigor occurs, the temperature rises rapidly and remains constantly elevated, the pulse becomes rapid, and later on very weak and thready in character. The patient may complain of intense pain, which is at first limited to the lower portion but gradually extends over the entire abdomen. At the same time there is marked tympanites, and the abdominal walls are rendered tense by the distended intestines. If a fatal issue ensues death usually occurs within the first ten days of the puerperium, the patient gradually sinking, although she may remain conscious to the last. In many cases, however, the temperature is but little elevated, the pain slight, and the abdominal symptoms slightly marked, or even absent, the serious character of the condition being indicated only by the rapid and compressible pulse and the drawn and haggard facies.

In the cases of *pyæmia*, on the other hand, the clinical picture is very characteristic. Here the initial chill rarely occurs before the end of the first week, and the temperature does not remain constantly elevated, but instead we have a typical hectic fever, with the chill, high temperature, and remission recurring in succession. The symptoms vary very considerably, according as one has to deal with the dislodgment of a single thrombus or of the constant entry into the blood of small infected particles. In the first instance a metastasis develops at some one point, the symptoms depending upon the organ involved. On the other hand, if thrombi are being constantly dislodged we may have symptoms referable to various organs.

One of the most constant manifestations of *pyæmia* is an infectious broncho-pneumonia, which contributes to the fatal termination. In other cases swellings occur at the various joints, which frequently eventuate in suppuration and lead to total destruction of the tissues implicated. Abscesses may also develop in the internal organs or appear upon the surface, and in several instances I have seen them lead to the destruction of the



eye. The course of pyæmia varies very materially according to the organs attacked and the resisting powers of the patient, but it is nothing like so uniformly fatal as the peritonitic form of infection.

In rare instances the infection is so virulent that the bacteria do not have a chance to become localized in any one organ, and both they and their toxins are found in abundance in the circulating blood, with very slight implication of the uterus. This happens in cases of so-called acute *septicæmia*—the sepsis foudroyante of the French writers—which represents the most rapidly fatal form of infection, the patients occasionally dying on the second or third day of the puerperium in a condition of shock, and without the development of local symptoms. A case of streptococcus septicæmia, observed in my out-patient department, ended fatally within eighteen hours after the initial rise of temperature.

In a small number of cases the thrombotic process involving the pelvic veins may extend to the femoral vein on one or both sides, giving rise to *phlegmasia alba dolens*. This accident, as a rule, does not make its appearance until some time in the second or third week of the puerperium, or even later, the first symptom being pain along the course of the femoral vessels, which, in thin individuals, may be felt as hard, sensitive cords. At the same time œdema appears in the feet and soon extends upward, though occasionally it may appear first in the thigh. This swelling is associated with severe pain, and usually lasts for a considerable time, months sometimes elapsing before the patient can walk with comfort. At the same time the condition is rarely fatal unless some complication occurs. At the onset of phlegmasia many patients complain of severe pain about the chest. This symptom is attributed by Pinard and Wallich to the arrest of minute emboli in the smaller vessels of the lung, with subsequent infarction and the development of isolated areas of pleurisy.

In a certain number of cases infection may occur before the birth of the child. This is designated as *intra-partum infection*, and usually occurs in slow labors in which the membranes have ruptured prematurely. In such circumstances the temperature may be markedly elevated and the patient present a profoundly septic appearance even before delivery. When the temperature during labor rises above 100.5° F., we should always think of this complication, and at once institute procedures to hasten the evacuation of the uterus.

\* **Diagnosis.**—The diagnosis of puerperal infection is usually made without difficulty, as the clinical history is very significant.

If a patient, who has been doing well after delivery, has a chill and a rise of temperature on the third or fourth day, we may be practically sure that we have to deal with an infection, unless the symptoms can be accounted for by some other satisfactory explanation. In many cases the initial chill does not occur, and the first indication of the condition is a rise of temperature. In general, a temperature exceeding 100.4° F. (38° C.), and persisting for more than twenty-four hours, should be regarded as a *prima facie* evidence of infection.

In the old times it was believed that the onset of the lacteal secretion was accompanied by fever, and the older observers were always ready to

attribute a rise of temperature on the third or fourth day to this cause. At present, however, this so-called "*milk fever*" is no longer regarded as a morbid entity, as we know that the normal puerperium should be absolutely afebrile.

After the infection has become well established, either as an endometritis, peritonitis, or one of the other forms, the diagnosis is generally easy. In uncomplicated cases of puerperal endometritis usually very little pain is complained of, and it sometimes becomes a difficult matter to decide positively whether the temperature is due to a uterine infection or some other cause.

Occasionally a febrile movement may occur late in the first week, which may justifiably be ascribed to *emotional causes*, such as excitement, fright, or grief. The temperature may rise suddenly, and after reaching a considerable height promptly fall to normal within a few hours. At first we should always suspect a beginning infection, and it is only after the rapid subsidence of the symptoms that such a diagnosis is permissible. Now and again a somewhat similar rise is caused by *auto-intoxication from the intestinal tract*. Budin and Galtier state that in some instances such a condition may closely simulate puerperal infection. The diagnosis, however, is readily arrived at by the administration of a purgative, for after a copious movement of the bowels the temperature falls rapidly and remains normal. Again, fever occurring in the early part of the puerperium is not uncommonly due to inflammatory troubles about the breasts, but the subsequent history of the case readily clears up the question of diagnosis.

In addition to the more usual causes of fever during the puerperium not due to infection, many intercurrent diseases may be accompanied by a chill and high temperature which for a short time may make one suspect puerperal infection, although the subsequent history shows that one's fears have been groundless. This is frequently so in angina and acute pulmonary affections which may occur at any time during the puerperium. Occasionally prolonged suppurative processes in the pelvis, or other parts of the body, may be accompanied by symptoms which may readily be confounded with puerperal infection, but in the present state of our knowledge there is no reason why we should long remain in doubt as to the cause and origin of the fever in a given case.

There are two diseases, however—malaria and typhoid fever—which are frequently confounded with puerperal infection, and which are often made the scapegoat to shield the practitioner who has neglected aseptic precautions in the conduct of his case. While there is no doubt that either of these affections may occur during the puerperal period, in the vast majority of cases the diagnosis is open to question.

If the symptoms be due to malaria one should be able to demonstrate the presence of the specific parasites in the blood; but in default of a positive finding one is not justified in making such a diagnosis. Indeed, it would be far better to go still further and to hold that one should never exclude puerperal infection as a probable causative factor unless cultural methods have demonstrated that the uterine cavity is free from pyogenic organisms; for it is possible in exceptional cases that a puerperal infection



may be associated with malarial poisoning, and, without the bacteriological examination of the uterine lochia, after finding the specific plasmodia in the blood, one might be satisfied of the exclusive malarial origin of the symptoms, whereas, in reality, they are partially due to infection. If these criteria were applied a malarial fever complicating the puerperium would appear in health statistics far less frequently than at present.

On the other hand, there is no doubt that occasionally a latent malarial infection may suddenly burst out again during the puerperium. Thus, in several of our cases the women had chills followed by fever, and we were able to demonstrate the presence of tertian malarial organisms in the blood, and at the same time to make sure of the absolute sterility of the uterine lochia.

The diagnosis of typhoid fever is very frequently made in prolonged cases of puerperal infection, being based on the long-continued fever and the general prostration of the patient. No doubt such a complication occasionally occurs, but any one who will make a point of inquiring fully into the many instances of which he hears will soon be convinced that only a small proportion of the cases so designated are really typhoid in origin, but that most of them depend upon an infection of the genital tract. In the present state of our knowledge we are not justified in making a diagnosis of typhoid fever unless a positive Widal reaction can be demonstrated.

On the other hand, typhoid fever complicating the puerperium may simulate very closely a puerperal infection. Jung has described several cases in which this mistake was made, the true nature of the malady not being discovered until autopsy, and I have had a similar experience. Likewise, an acute miliary tuberculosis, or the flaring up of a chronic process during the puerperium, may occasionally simulate an infection, or may mask its symptoms. In one of my patients, with ~~severe~~ pyæmia following a brutal delivery, streptococci were demonstrated in the blood and uterine lochia, and several superficial abscesses developed. Later pulmonary symptoms appeared, and for a time it was thought that we had to deal with a metastatic process, until the demonstration of tubercle bacilli in the sputum cleared up all doubt.

To sum up, it may be safely said that every rise of temperature observed in a puerperal woman should be regarded as due to infection until it has been clearly demonstrated that some other exciting cause is responsible. Hence it follows that, in making a diagnosis of any febrile affection complicating the puerperium, an accurate and complete physical examination of the patient is necessary, and at the same time all the aids which the recent advances in microscopy and bacteriology have placed at our command should be utilized.

*Bacteriological Examination of the Lochia.*—As the most common lesion in puerperal infection is an endometritis, it is a matter of great importance to decide whether one has to deal with the septic or putrid variety; but although in many cases the clinical symptoms will give tolerably definite indications, a positive conclusion can be arrived at only after a bacteriological examination of the uterine lochia. In gonorrhœal infections the development of a purulent ophthalmia on the part of the child affords an

almost positive diagnosis, but even in such cases one is not sure that other organisms may not be concerned.

Cultures may be taken from the interior of the uterus with comparatively little difficulty by means of a simple device first introduced by Döderlein and modified by H. M. Little. This consists of a glass tube 20 to 25 centimeters in length and 3 to 4 millimeters in internal diameter, with a slight bend at one end so as to conform to the anteflexed condition of the uterus. It is then threaded with a piece of strong silk, to one end of which a folded rubber band is attached, which exerts suction when traction is made upon the free extremity protruding from the other end of the tube.

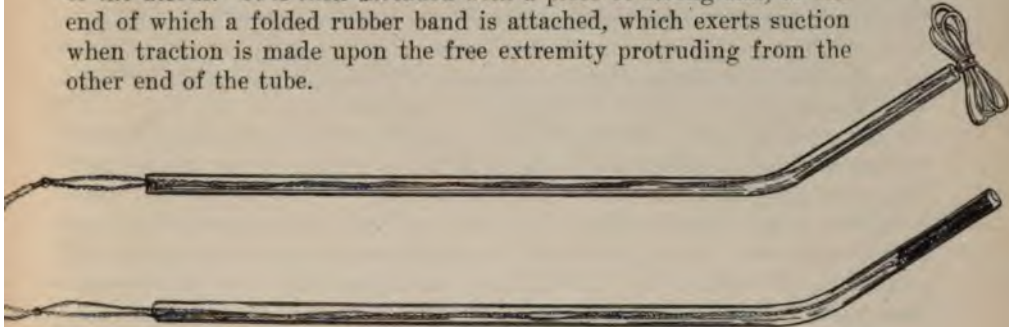


FIG. 668.—LITTLE'S TUBE FOR OBTAINING UTERINE LOCHIA.

When cultures are to be made the instruments and lochial tube are sterilized by boiling, and the hands of the operator and the external genitalia having been thoroughly disinfected, the patient is placed in the Sims's or dorsal position and the cervix exposed by a suitable speculum. It is then seized with a volsellum forceps and, its vaginal portion having been carefully cleansed with a bit of sterilized cotton, the lochial tube is introduced as far as possible into the uterus, care being taken to avoid touching the external genitalia with it during the manipulation. On making traction upon the thread protruding from the free end of the tube, a partial vacuum is created and a certain amount of uterine lochia is drawn up. The tube is then removed from the uterus and its ends hermetically closed with sealing wax. After being taken to the laboratory it is broken in its middle portion and cultures are made from the contents (Fig. 668).

This method, although it may appear to be somewhat complicated, can be readily carried out by any practitioner who is conversant with the ordinary rules of surgical technique, and if the tube be sent to a competent bacteriologist for examination, it can be determined within twenty-four hours whether the infection is due to pyogenic or putrefactive bacteria, and whether one has to deal with a dangerous or a comparatively harmless condition. Furthermore, this knowledge frequently gives important indications as to treatment.

In my practice such a procedure forms a part of the routine examination in every case presenting a rise of temperature above 101° F., and gives most reliable information if employed during the week following delivery. After that period, however, the results are not so decisive, as the uterine lochia in the latter part of the puerperium practically always contain putrefactive bacteria. I consider that this technique is far preferable



to the examination of the vaginal lochia obtained by means of diphtheria swabs, as recommended by Veit, Fromme, and other German authorities. The former method gives precise information concerning the bacterial contents of the uterus, while in the latter one simply infers that the uterine and vaginal flora are identical, which is by no means always the case.

As has already been indicated, it was for a time believed that the demonstration of the presence of hæmolytic streptococci always indicated the existence of a virulent infection. The work of Sigwart, Lea, and others, however, has shown that this is incorrect, as we now know that such bacteria are occasionally present in the lochia of women who are but slightly ill. At the same time, their presence is always highly suggestive, and should always lead to strict isolation of the patient.

Hirst believes that the examination of the uterine lochia may lead to erroneous conclusions, as it may give negative results, while at the same time bacteria can be cultivated from the blood. In my experience, however, this is not the case during the first ten days of the puerperium, but after that period, and especially in certain prolonged cases of pyæmia, his contention may be correct. On the other hand, if reliance were placed solely upon blood cultures, practically all of the mild and some of the severe cases of infection would escape differentiation. In the former, bacteria rarely gain access to the circulation, while in the latter the reverse usually holds good; although I have seen several women die from infection in whom repeated examination of the blood gave negative results both during life and at autopsy.

In my opinion, therefore, the bacteriological examination of the blood is of secondary importance from a diagnostic point of view, although it should always be made, as the demonstration of streptococci adds to the gravity of the prognosis. At the same time, it does not necessarily indicate a fatal termination, as I have repeatedly seen such patients recover, and in many instances they appeared to be but slightly sick.

After removing the lochia for bacteriological examination, provided the cervix is sufficiently patulous, it is well to introduce the sterile finger into the uterus and feel its interior, after which a douche of several liters of normal salt solution should be given. Palpation of the cavity of the uterus enables us in many cases to predict in advance the result of the bacteriological examination, and, what is of more practical value, it gives us important information as to the line of treatment to be pursued. Thus, in putrid endometritis we usually find the interior of the uterine cavity rough and covered with shreds of broken-down tissue; while in the septic forms it is often perfectly smooth.

The macroscopic appearance of the lochia is also of considerable value, for in putrid endometritis the discharge is frothy and frequently very offensive in odor, while in pure streptococcic infections it is very little changed from the normal. This distinction needs to be especially emphasized, since the first question which the practitioner usually asks in the presence of fever during the puerperium is whether the lochia are foul-smelling or not, and if he receives a negative answer he is too apt to think that the fever is of other than uterine origin. As a matter of fact, the

reverse is almost constantly true, and, as a rule, the foulness of the odor is in inverse proportion to the danger to which the patient is exposed.

When the process has extended beyond the uterus the diagnosis is much more readily made, and, provided that malarial or typhoid fever and acute miliary tuberculosis have been positively excluded, it is hardly possible to mistake the symptoms produced by a peritonitis or by a pyæmia. In the cases of parametritis and suppurative affections of the tubes and ovaries, bimanual examination will demonstrate the presence of a mass on one or other side of the uterus, if the tumor has not already made itself evident to abdominal palpation.

**Prophylactic Treatment.**—In considering the treatment of puerperal fever, prophylaxis should occupy the most important place. As has been repeatedly insisted, puerperal infection is wound-infection, and is due to the introduction of pyogenic micro-organisms by the hands or instruments of the doctor or nurse. Hence, it follows that the most scrupulous asepsis immediately before and during labor is the means upon which we have mainly to rely to limit its occurrence. Every physician who conducts a labor case cannot feel too strongly his personal responsibility in this connection, and he fails to do his full duty to his patient unless he regards the rules of asepsis as carefully as when performing a capital surgical operation. This question in all its various phases has been fully dealt with in the appropriate chapters.

All that has been said concerning the necessity of cleanliness and asepsis on the part of the physician applies equally well to the nurse, and in all her manipulations about the patient she should never forget her responsibility in this respect. Moreover, she should be strictly forbidden to make vaginal examinations or give douches except at the direct request of the physician in charge.

As long as vaginal examinations are made, infection will occasionally occur, even though the carefully disinfected hand be covered by a sterile rubber glove. As it is impossible to disinfect the vulva thoroughly, it must inevitably happen that bacteria are carried up into the vagina from it with each examination, and it is therefore not surprising that they occasionally give rise to infection. For this reason vaginal examinations should be dispensed with as far as possible, and with this end in view the accoucheur should never lose an opportunity of perfecting himself in the methods of rectal and external examination.

In view of what has already been said concerning practical sterility of the normal vaginal secretion, as well as the results of the investigations of Leopold and others, which have been confirmed by my own experience, I strongly advise against the employment of the *prophylactic douche* as a routine procedure, believing that it should be resorted to only when the vaginal secretion presents marked evidences of abnormality.

During the second stage of labor it is well to have the vulva covered with an aseptic pad in the form of a towel soaked in bichloride solution. This is done not so much for fear of infection from the air as to prevent the possibility of contamination from the patient's hands. The third stage of labor likewise offers many facilities for infection, and too much stress



cannot be laid upon its proper conduct. Speaking broadly, the generative tract after the birth of the child should be regarded as a *noli me tangere*, unless an emergency, such as hæmorrhage or an adherent placenta, necessitates the introduction of the hand.

The recommendation that a routine vaginal examination is called for at the conclusion of the third stage of labor, in order to detect cervical tears with a view to their immediate repair, cannot be too strongly deprecated, and those who follow it will inevitably encounter a much larger puerperal morbidity than when vaginal examinations are reserved for exceptional and urgent cases.

Another point in the prophylaxis of puerperal infection is to close with sutures immediately after the conclusion of labor all perineal wounds, unless the procedure is contra-indicated by profound exhaustion on the part of the patient, or by a very œdematous condition of the tissues implicated. To save time, it is my practice to introduce the sutures immediately after the birth of the child, and while waiting for the expulsion of the placenta.

To recapitulate, the liability to puerperal infection will be materially lessened by the strict observance of the following: (1) The maintenance of strict asepsis by the obstetrician and nurse before, during, and after delivery; (2) the restriction of vaginal examinations within the narrowest limits possible; (3) the omission of vaginal douches except in certain rare cases; (4) the immediate repair of perineal lacerations which might otherwise offer foci for infection; and (5) regarding the genital canal of the puerperal woman as a *noli me tangere*, into which neither finger nor instrument should be introduced except in emergencies.

**Curative Treatment.**—The curative treatment of puerperal infection is a question concerning which there is a great deal of dispute, and it is probable that what is said here may be directly opposed to the usual practice of many physicians.

If a puerperal ulcer is situated about the vulva or on the lower portion of the vagina, it should be occasionally touched with pure carbolic acid or tincture of iodine, and the parts kept as clean as possible. If the repaired perineum breaks down and suppurates, the stitches should be removed in order that free drainage may be provided.

As has been said, puerperal endometritis is the form of infection most frequently encountered, and unfortunately the directions for its treatment differ widely and are often contradictory.

As soon as the patient's temperature reaches 102° F., unless a uterine infection can be excluded with a fair amount of certainty, the uterine lochia should be examined bacteriologically. When feasible, immediately after having withdrawn the tube, the interior of the uterus should be carefully explored by the sterile index finger, after which, by means of careful bimanual examination, the condition of the appendages and the broad ligaments is determined. If the uterine cavity is perfectly smooth, local treatment should be limited to a douche of several liters of boiled water or normal salt solution. On the other hand, if its interior is rough and jagged and contains more or less *débris*, it should be thoroughly cleaned out with the finger, after which an abundant saline douche should be employed.

*Curettage* as a routine measure in all cases of puerperal endometritis cannot be condemned too strongly, for the reason that in the most severe cases there usually is nothing in the uterine cavity which can be removed, and its employment can only do harm by breaking down the leukocytic wall which serves to prevent the invasion of the deeper layers of the uterus by the offending bacteria. On the other hand, when the uterus contains much *débris*, its removal is quite as readily, and much more safely, effected by means of the finger.

This teaching is directly contrary to that of many American, British, and French writers, who enthusiastically recommend the use of the curette in all cases of puerperal infection, although Pinard, since 1905, has practically abandoned its use. Fritsch, whose views represent the conservative German doctrines on the subject, would reserve its use for exceptional cases, and certainly my experience has convinced me of the advisability of this restriction.

The routine use of intrauterine douches containing bichloride, carbolic acid, or other disinfectants in the treatment of these cases is contraindicated on several grounds. In virulent streptococcus infection, histological examination shows that the organisms have penetrated deep down into the tissues by the time the initial chill and rise of temperature occur. Under these circumstances the employment of an antiseptic douche is not rational, inasmuch as the germicidal fluid cannot possibly penetrate the uterine wall sufficiently deep to reach the bacteria which are giving rise to the symptoms and upon which the further spread of the disease is dependent.

Moreover, it has been shown experimentally by Bumm that bichloride injections penetrate the tissues only to a very slight extent. He took the liver of an animal dead of anthrax, and after soaking it for thirty minutes in a 1-to-1,000 bichloride solution placed it upon a freezing microtome and cut thick sections from it. After cutting off about 1/10 of a millimeter, he inoculated the next section into another animal, which succumbed to anthrax, thus showing that the germicidal action of the bichloride had been exerted only upon the surface. If this be the case in the laboratory, where the tissues can be immersed in the antiseptic solution, what effect can we expect upon organisms embedded in the muscular wall of the uterus from the transitory application to the surface of a few liters of a weak bichloride solution? Bumm likewise showed that the streptococci make their way through the uterus with great rapidity, traveling 2 centimeters or more in the space of six hours. What has been said concerning bichloride applies equally well to the other disinfectants.

On the other hand, their employment in putrid endometritis is even less rational, as in such cases simply cleaning out the uterus with the finger, followed by a douche of sterile salt solution, will lead to a rapid fall of temperature and the amelioration of untoward symptoms. The object in giving a douche in these cases is simply to wash away the *débris* which has been left behind by the finger, and for this purpose sterile salt solution is superior to any antiseptic fluid.

In addition to these somewhat theoretical objections, there is this very



practical one: that the employment of antiseptics in amount of harm. Not a few cases of sudden collapse: carbolic-acid douches are on record, while in some injections of bichloride have been proved to have been death. Several years ago, at the autopsy upon a woman to have died from puerperal sepsis, I found all the a bichloride poisoning, so that, to say the least, it remains the infection or the treatment instituted for its relief the fatal issue.

On reference to the literature at that time, I coll in which death had followed the employment of bichlor the puerperium. In many instances, to be sure, exc been employed, but in several a single injection of sev 4,000 solution had resulted in fatal mercurial poisoning are taken into consideration, along with the theoretic employment of antiseptics under these circumstances, i the benefit to be expected from their employment is lematical, while the dangers are very real.

The same considerations likewise apply to the vari agents which have been recommended from time to inclined to place great confidence in the disinfectant tions of alcohol, as recommended by Wetherill, Sit At the same time it must be admitted that the unifo by the latter in 246 cases of infection speaks in its absence of bacteriological data somewhat weakens his c

The results following the method of treatment jus as good as those obtained with the various antisepti contention is sustained by the experience of Bumm an means I have had a mortality of less than 10 per c streptococcic endometritis, which would be still furth to exclude the patients who were suffering from ge severe pyæmia at the time of admission. At the same t to give the impression that pure streptococcic infection ger, as they are always serious and often fatal, and I be able results are probably attributable to the fact that r included in our series, which would have escaped dete bacteriological examination of the lochia in all febrile our results would appear to indicate that too energeti harmful, and that an equally good or better outcome safer and more conservative measures.

To recapitulate, in dealing with a case of puerpera having removed some of the uterine lochia for culture be explored by the sterile finger and cleaned out or i condition. The uterus should then be douched with se salt solution. If the bacteriological examination sho streptococci all local treatment should at once be o other hand, one has to deal with a putrid endometritis do not yield to the first injection, additional douches n

the infection has extended beyond the uterus local treatment should not be persisted in, as it will do more harm than good.

Bumm redirected attention to the observation made by Guérin in 1858 that in many instances involution had taken place very incompletely, and he therefore recommended the employment of ergot to secure better contraction, thereby occluding to some extent the lymphatics in the uterine wall. My own experience is in accord with this view, and in cases in which the uterus is larger than it should be at a given period of the puerperium the employment of the drug would certainly appear to be indicated.

In gonorrhœal endometritis active treatment is not required at the time, since in the vast majority of cases the slight rise of temperature associated with the onset of the disease soon falls to normal, and the patients recover spontaneously, or are left with a chronic endometritis and diseases of the appendages, which can be treated much more advantageously at a later period.

In all severe cases general tonic measures that will serve to keep up the strength of the patient and increase her resistance to the infective virus are most valuable. The most reliable drugs are strychnine and alcohol, and it is a matter of experience that these patients can bear much larger quantities of the latter than when in health. High fever should not be combated with antipyretics, the external application of cold, either in the form of spongings or cold baths, being preferable. Hydrotherapeutic measures have been enthusiastically advocated by Runge and others, and in their hands have given very satisfactory results.

If the process has extended beyond the uterus, and we have to deal with a parametritis or a pelvic peritonitis, dry or moist heat to the lower portion of the abdomen, in the form of poultices or other hot applications, is to be recommended.

Occasionally, surprisingly good results are obtained in profoundly septic conditions by repeated subcutaneous injections of sterile salt solution. Attention was first directed to this method of treatment by Bosc, and subsequent experience has in great part justified his predictions.

Of late a great deal has been written on the *operative treatment* of puerperal infection, nearly every prominent obstetrician and gynæcologist having made some contribution to the subject. Every one is agreed as to the advisability of opening parametric abscesses as soon as fluctuation appears rather than allowing them to rupture spontaneously. Not uncommonly, in cases of parametritis, on palpation a semi-fluctuant sensation is conveyed to the examining finger which may lead one to imagine that one has to deal with pus, whereas upon opening the supposed abscess through the vagina or abdominal wall, as the case may be, the tumor turns out to be a mass of inflammatory exudate without pus formation, and only a small amount of serous fluid escapes when it is cut into. Fortunately, incision into these masses frequently gives as good results as if a considerable quantity of pus had been evacuated, just as happens in cases of cellulitis in other portions of the body.

When pus tubes or ovarian abscesses can be made out by bimanual palpation, their removal is indicated, for as long as they remain the patient



will continue in a septic condition. At the same time it should be remembered that in streptococcic infections the bacteria may retain their virulence for long periods, so that abdominal operations are much more dangerous than at other times. For this reason interference should be delayed as long as possible, and in the early part of the puerperium should be attempted only when urgently indicated. Whether such conditions should be dealt with by laparotomy or by puncture through the vagina will depend upon the particular case. If they are freely movable, laparotomy should be performed; whereas if they are adherent and readily accessible from below, vaginal puncture with subsequent packing of the abscess cavity with gauze is to be preferred.

The chief point of discussion concerning the operative treatment of puerperal infection has been as to the advisability of removing the infected uterus at an early period. Here the various surgeons take quite opposite views, the more radical advocating its prompt removal, while the more conservative do not regard this step with favor.

For two reasons it would appear that *hysterectomy* is usually contraindicated in puerperal infection. In the first place, if one operates at a period sufficiently early to prevent the extension of the process to other organs, a large number of uteri will undoubtedly be removed unnecessarily; on the other hand, if one waits until a later period, when other organs have become implicated, the operation will also be useless. Nevertheless, there is a restricted field for hysterectomy in those cases in which the process has not extended materially beyond the uterus but has given rise to abscess formation within its walls. Again, in a putrid endometritis, when all other attempts to check the disease have proved futile, the operation would appear to be justifiable.

Lusk suggested that hysterectomy may sometimes be useful in the cases of pyæmia in which infected thrombi are carried from the uterus to various portions of the body, giving rise to a hectic condition. As a rule, however, the thrombotic process has extended far beyond the uterus by the time symptoms appear, and consequently the removal of the uterus would be useless. Much more practical is the suggestion of Freund, Trendelenburg, and Bumm, that the thrombosed vessels be exposed by laparotomy, and excised or ligated distal to the thrombus, as may seem most expedient, just as is done in the case of infected thrombi complicating mastoid disease. In 1909 I reported five such operations with four recoveries and reviewed the literature up to that time. In appropriate cases I regard the operation as most valuable.

Until very recently the development of general peritonitis was considered almost necessarily fatal, and in such cases the treatment was usually perfunctory. But in the past few years Sourdille, Kownatski, Leopold, Boquel, and others have shown that recovery may occasionally follow after freely opening and draining the abdominal cavity. Cragin, on the other hand, reports that his results were not encouraging, and my experience has been the same. In view, however, of the almost certainly fatal outcome of expectant treatment, such interference would seem justifiable in appropriate cases.

In certain cases of infection following criminal abortion Pryor, Robb, Sourdille, and others have reported encouraging results following wide incision of the posterior fornix and packing Douglas's *cul-de-sac* with iodoform gauze. In many such cases serous or purulent fluid escapes from the incision, so that it would appear that such a procedure may be of value in preventing a pelvic peritonitis from becoming generalized. In my limited experience this procedure has not appeared to exert an appreciable influence upon the course of the disease, but in view of the high standing of its sponsors it is worthy of trial.

The prospects of coping more successfully with puerperal infection were greatly brightened in 1895 by Marmorek's announcement of the discovery of an *antistreptococcic serum*. Unfortunately, up to the present time the results of serum therapy have not proved more satisfactory than other methods of treatment. In May, 1899, a committee of the American Gynecological Society, of which I was chairman, made an exhaustive report upon the subject, giving the complete literature and collecting all the cases treated by serum reported up to that time. It was found that 352 cases of puerperal infection had been so treated, with 73 deaths—a mortality of 20.74 per cent. In a large number of cases the lochia were not examined bacteriologically, and there was therefore considerable doubt as to whether the infections were due to the streptococcus; but in 101 cases in which its presence was demonstrated there were 33 deaths—a mortality of 32.69 per cent.

This was a very discouraging showing, especially when compared to the results obtained by Krönig and myself without serum therapy. The question therefore arises, Was the high mortality attending the use of the anti-streptococcic serum due to its employment or to other causes? Our investigations having indicated that the serum was practically harmless, the poor results following its use can probably be explained in one of two ways: first, that only exceptionally severe cases had been treated; and, secondly, that a large number of the cases so treated had already been curetted—a procedure which is often followed by untoward results. In view of these facts the committee reported that while there was no evidence in favor of the therapeutic value of the serum, it apparently did not exert a deleterious effect upon the patient, and therefore might be employed if the physician so desired.

Following the report of our committee the general consensus of opinion has been that Marmorek's serum had failed to substantiate its value, and is practically useless as a therapeutic agent. More recently the work of Aronsohn, Tavel, Menzer, Meyer, and others has directed renewed attention to the subject. As the result of their investigations, it has been shown that in order to produce an effective serum for use in human beings the streptococcus should not be passed through lower animals, but that as many strains as possible of virulent bacteria, obtained from human sources, should be employed for immunizing the animal from which the serum is to be obtained.

It was then shown that the serum did not neutralize the toxins, as is the case with anti-diphtheritic and anti-tetanic serum, nor act directly upon



the bacteria, but merely gave rise to conditions which favored phagocytosis—in other words, increased the opsonic power of the blood. Moreover, experimental work has demonstrated that while the serum might possess marked prophylactic value and be able to protect an animal against inoculation with many times the ordinarily fatal dose of streptococci, it was lacking in curative properties, and at most was of value only in the initial stages of infection, being without apparent effect when the process had become fully established. At the same time it was found to exert no deleterious effect upon the patient and might be administered with impunity.

Therefore, it may be said that the prospect of cure is very slight when the serum is administered to very sick patients, though, if given prior to the onset of serious symptoms to those who have been exposed to the possibility of infection, it may have some prophylactic value. Modern antistreptococcic serum has been employed in large series of cases by Bumm, Walthard, Peham, Raw, Pinard, and others, but does not appear to have exerted an appreciable effect upon the course of the disease. The subject was exhaustively considered by Freund in 1910 in the *Handbuch der Serumtherapie* of Wolff and Eisner.

It is always difficult to arrive at correct conclusions as to the value of any given therapeutic agent, unless large numbers of cases are used as a basis, and this is particularly true in the affection under consideration, for the reason that its clinical course is so very variable. Thus, it is not at all rare in cases of streptococcic infection to see the temperature rise rapidly to 103°-105° F., remain there for a day or so, and then fall as rapidly as it had risen. This may occur without the use of any treatment, and had the specific serum been employed in such cases it is probable that the rapid amelioration of symptoms would have been attributed to its use.

Some hope has been entertained that satisfactory results might be obtained by use of bacterial vaccines. Sir Almroth Wright, however, informed me that he had no such expectation as to streptococcic infections, although improvement might be expected in certain chronic cases due to the staphylococcus or gonococcus. A collective investigation by a committee of the American Gynecological Society in 1910, of which I was chairman, has served only to confirm his conclusions. At the same time it should be mentioned that Polak is more optimistic and believes the use of vaccines is sometimes followed by surprising results.

That we as yet possess no satisfactory treatment for all cases of puerperal infection is indicated by the vast number of methods advocated. Only a few of the more recent need here be mentioned.

Hofbauer, in 1896, reported several cases of puerperal sepsis in which an artificial leukocytosis was produced by the employment of nuclein. In some of his cases the temperature fell by a lysis and in others by crisis, and he believed that the treatment played a marked part in their cure. He made a second communication in 1903, and claims that extended observation has confirmed his original statements.

Reference need scarcely be made to the employment of intravenous injections of formalin, as advocated by Barrows, in 1903, as subsequent

investigation has shown that they are not only of no value, but are absolutely harmful.

A considerable literature has accumulated upon the employment of Credé's ointment, and the intravenous injection of collargol or a solution of silver nitrate in puerperal infection. The report of Osterloh, however, clearly shows that they are of but slight value, and act only by promoting phagocytosis.

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## CHAPTER XLIV

### DISEASES AND ABNORMALITIES OF THE PUERPERIUM

We have already discussed in detail the more typical instances of puerperal infection. We shall now take up certain atypical varieties—tetanus, phlegmasia alba dolens, and cystitis—and shall then proceed to consider certain other diseases and abnormalities which may be encountered in the puerperium, but which are not due to the introduction of infective material into the genital tract. Thus, we shall find that fever associated with constitutional disturbances is frequently met with, as the result of pathological conditions in the breasts, disorders of the intestinal tract, and in very rare instances may be due to emotional causes. Moreover, it must be remembered that Nature has not rendered the puerperal woman exempt from the various disorders from which she might suffer at other times.

**Tetanus.**—The undoubted development of tetanus during the puerperium, although a very rare occurrence, has been fully established by the researches of Chantemesse and Widal, Heyse, Rubeska, Schotmüller, and others, who have isolated the characteristic bacilli from the uterine lochia. The infection usually follows gross errors in aseptic technique, especially during operative procedures. Thus, in several of the reported cases, it is recorded that the operator placed the forceps upon the dirty floor by the side of the bed, and afterward carried it directly to the genital tract of the patient. Occasionally, however, such an explanation cannot be adduced, as in an epidemic in the Prague Lying-in Hospital, the disease, in one instance, at least, occurred in a woman who had not even been examined internally.

Tetanus follows abortion more frequently than full-term labor, and as a rule gives rise to untoward manifestations between the sixth and tenth days of the puerperium, and sometimes later, though in rare instances the first symptom has been known to appear before the completion of labor. The prognosis is very grave. All of the 20 patients mentioned by Rubeska succumbed, while Vinay reports a similar result in 94 out of the 106 cases included in his statistics.

Beyond affording means for temporarily controlling the symptoms, therapeutic measures are valueless, and thus far the results obtained from the employment of anti-tetanic serum have not been encouraging, although its prophylactic employment has been attended by excellent results. In view of the hopelessness of other lines of treatment, Pawlik and Rubeska removed the uterus in several of their cases, but without avail.

**Thrombosis of the Vessels of the Lower Extremities.**—Thrombosis occurring in the crural, popliteal, or saphenous veins—*phlegmasia alba dolens*—is usually a manifestation of puerperal infection, and follows the direct extension of a thrombotic process from the pelvic veins, occasionally it results from a localized phlebitis or periphlebitis, and in very rare instances may be due to purely mechanical factors. The lumina of the large veins rarely undergo complete obliteration, so that the circulation, while markedly interfered with, is not completely shut off.

*Symptoms* do not usually make their appearance until the latter part of the second week of the puerperium, or even later. In most cases the first manifestation is pain in one leg extending along the course of one of the larger veins; this is soon followed by œdema, which usually begins in the foot and extends upward, although occasionally it appears first in the neighborhood of the groin. The leg soon becomes much swollen, the skin being tightly stretched and presenting a glazed appearance, but at first pitting can be elicited only after prolonged pressure with the finger-tip. If the crural vein is implicated a very sensitive cord-like structure can often be palpated just beneath Poupart's ligament and can be followed for a certain distance down the thigh.

The inflammatory changes are usually attended by some elevation of temperature, the pulse being more or less accelerated. High fever and a very rapid action of the heart usually indicate that similar processes exist in other portions of the body, and that the patient is suffering from a pyæmia, incident to a more or less generalized thrombo-phlebitis. The pain, swelling, and temperature continue for several weeks, and then gradually subside, though occasionally months elapse before the patient regains the full use of the leg.

Ordinarily, the process is limited to one side, more rarely both extremities are affected, an interval of a week or ten days elapsing before the second leg becomes implicated. If properly treated most cases undergo spontaneous cure, the condition being dangerous only when it forms part of a generalized process, or when the thrombus undergoes suppuration and softening, so that infected particles are carried to other parts, giving rise to metastatic abscesses and occasionally to sudden death from pulmonary embolism.

*Treatment.*—Complete rest is absolutely essential. The lower part of the leg should be elevated, and the entire member encased in absorbent cotton and protected from the weight of the bedclothes by a suitable contrivance. If the pain is severe morphine may be required, though ordinarily the application along the course of the thrombosed vein of cloths soaked in lead water and opium is followed by marked relief. Excellent results have been reported from painting the leg with a 15- or 20-per-cent. solution of ichthyol.

On account of the danger of detaching portions of the thrombus, the leg should never be massaged. The patient should be kept in a horizontal position for at least a week after the pain has disappeared and the temperature subsided, and after being allowed to get up she should be cautioned against making sudden movements.



Small varicose veins of the lower extremities sometimes undergo spontaneous thrombosis during pregnancy, but more often during the first weeks of the puerperium. In pregnancy this occurrence is favored by the interference with the circulation due to the pressure exerted by the uterus upon the vessels returning from the extremities. During the puerperium its development is occasionally favored by pressure exerted upon the intrapelvic veins by inflammatory exudates. In small veins the thrombosis is usually unattended by symptoms, although now and again the development of a localized phlebitis or periphlebitis may cause pain, and exceptionally eventuate in the formation of a small abscess.

**Gangrene of the Extremities.**—In very rare instances, as the result of extensive thrombosis of the venous channels or of embolism of the arteries, the circulation in the extremities may become so impaired that gangrene results. This accident, first described by Churchill and studied more particularly by Wormser and Burckhard, is a most serious complication, and usually ends fatally. Wormser, in 1904, collected 80 cases from the literature, 6 of which were apparently examples of Raynaud's disease, while of the remaining 72 cases 66 occurred in puerperal, as compared with 6 in pregnant, women. The process usually involves one or both feet, although the hand or forearm may occasionally be implicated. Sixty-two per cent. of the 34 patients mentioned in Lafond's thesis died, in spite of the fact that in several instances amputation was resorted to in order to check the further development of the process.

**Diseases of the Urinary Tract.**—A *cystitis* occurring during the puerperium is usually the result of infection following catheterization, during which the rules of asepsis have not been scrupulously followed. The occurrence of the condition is favored by the presence of slight lesions of the vesical mucosa which frequently accompany easy and spontaneous labors, and are almost universally associated with difficult deliveries.

In view of the constant presence of bacteria in the normal urethra, and of the impossibility of thoroughly disinfecting the vulva and urethral orifice, cystitis will occasionally occur, despite the most rigid precautions. For this reason catheterization should be restricted to the greatest possible extent, and employed only when the patient is unable to evacuate the bladder after being placed in a sitting position. In rare instances the affection results from the direct extension of areas of inflammation about the urethral orifice and vulva.

As the process demands a certain period of incubation, symptoms do not usually appear for several days. The patient first experiences a frequent desire to micturate, but passes only a small quantity of urine at one time, the act being accompanied by a burning sensation in the urethra and a tendency to tenesmus afterward. At the same time, the bladder and the urethra become sensitive on pressure. The urine is usually cloudy, and upon microscopic examination is found to be loaded with mucus, leukocytes, epithelial cells, and bacteria. Occasionally it contains a large proportion of blood. The acid reaction is usually retained, although, more especially when the process is prolonged, the secretion may become alkaline, and very offensive in odor. Now and again cases are encountered in which the in-



fection is so severe that larger or smaller portions of the mucosa become exfoliated and are cast off with the urine, their expulsion being associated with cramp-like pains.

In these virulent types, and also in the milder but obstinate processes, the disease tends to extend up the ureters and to involve the pelvis of the kidney, giving rise to a *pyelitis*, which may be followed in a few weeks by a *pyelo-nephritis* or a *pyelo-nephrosis*. Thus, it sometimes happens that a patient, who had apparently recovered from a cystitis, may suddenly experience intense pain in one renal region, associated with the development of a temperature characterized by marked remissions and the passage of large quantities of urine laden with pus. The condition frequently apparently passes off, to recur again when least expected.

In mild cases of cystitis the *treatment* consists in the ingestion of large quantities of fluid, particularly milk and the carbonated and alkaline waters. The vesical irritability is often satisfactorily allayed by the administration of 5-grain capsules of salol or urotropin repeated every four to six hours. Ordinarily, simple treatment leads to recovery in a comparatively short time, but if the process drags on, daily irrigation of the bladder with a 2-per-cent. solution of boric acid or a 1-to-20,000 or 30,000 solution of bichloride should be practiced.

Most cases of pyelo-nephrosis recover spontaneously after rest in bed and the administration of large quantities of fluids and the usual renal antiseptics; but whenever a pyelo-nephritis is accompanied by prolonged febrile manifestations, drainage and occasionally extirpation of the organ becomes necessary.

*Retention of Urine.*—In Chapter XVI, upon the care of the patient during the puerperium, reference was made to the retention of urine, which frequently causes annoyance during the first few days of that period.

*Incontinence of Urine.*—In multiparous women, for the first few days of the puerperium, coughing, sneezing, or other factors leading to a sudden increase in the intra-abdominal pressure often produce an involuntary discharge of a small quantity of urine. The condition usually passes off spontaneously, but cure is sometimes hastened by the administration of 1/30 grain of strychnia every six hours.

More marked incontinence at this time is usually the result of lesions about the neck of the bladder following operative delivery, though when the condition does not manifest itself until the end of the first week it is usually the first sign of the development of a *vesico-vaginal fistula*. In the majority of such cases scrupulous attention to cleanliness will be followed by spontaneous recovery; but when the fistulous opening is extensive, a cure can be effected only by operative procedures at a later period.

**Hæmorrhages during the Puerperium.**—Ordinarily, if there has been no serious loss of blood during the first hour or hour and a half following delivery, it may be assumed that the danger of post-partum hæmorrhage has practically passed. Occasionally, however, in the latter part of the first week, and more often still later in the puerperium, more or less severe uterine hæmorrhages are encountered. They are nearly always due to the retention of portions of a placental cotyledon or of a succenturiate lobule



which may have been overlooked at the time of labor; although the retention of large portions of placenta indicates gross negligence on the part of the obstetrician. If the retained tissue is not cast off spontaneously or removed manually, it undergoes gradual necrosis, while at the same time fibrin becomes deposited about its periphery, giving rise to a polypoid growth of varying size—*placental polyp*—which so interferes with the involution of the adjacent portion of the uterus that bleeding continues so long as it remains in utero.

The retention of large portions of the foetal membranes rarely gives rise to serious hæmorrhage, as the tissues gradually disintegrate and are cast off with the lochial discharge. The presence of a remnant of decidua of any considerable size, which has failed to undergo the usual regressive changes, may act as an irritant upon the regenerating endometrium, giving rise to a hyperplasia which is designated as *endometritis decidua post-partum* or *post-abortion*, according as it follows full-term labor or abortion. It usually interferes with the process of involution, and leads to more or less hæmorrhage.

The diagnosis of the retention of a placental remnant or the existence of a polyp can only be verified by the sense of touch. Therefore, whenever a patient suffers from an acute loss of blood during the puerperium, the interior of the uterus should be carefully palpated, and any abnormal tissue promptly removed by means of the finger or curette.

The treatment of the slight hæmorrhage following retroflexion and subinvolution of the uterus has been referred to under those headings. The loss of blood associated with an endometritis post partum also demands curettage. If the patient bleeds excessively after the expulsion of an hydatidiform mole, similar treatment is indicated. And, on account of the possibility of the existence of a chorio-epithelioma, the tissue removed should be carefully examined microscopically.

*Puerperal Hæmatoma.*—A tumefaction resulting from the escape of blood into the connective tissue beneath the vaginal mucosa or the skin covering the external genitalia is known as a *vaginal* or *vulval hæmatoma*. This condition, first studied in detail by Deneux, in 1830, is a rare complication of labor and the puerperium, occurring about once in 1,500 or 2,000 cases. It occasionally originates during pregnancy, and may attain such proportions as to interfere with the descent of the child. Less frequently fatal hæmorrhage may follow its rupture at the time of labor, as in the cases reported by Künzig and others. The condition usually follows injury to a blood-vessel during the act of labor without laceration of the superficial tissues. Now and again it does not occur until later, and is then attributable to the sloughing of a vessel which had become necrotic as the result of prolonged pressure.

The site at which the hæmatoma develops varies according as the torn vessel lies beneath or above the pelvic fascia. In the former case the tumefaction involves the lower part of the vagina or the vulva and perineal region; while in the latter it protrudes into the upper portion of the vaginal canal, and as it increases in size separates the peritoneum from the adjacent tissues, so that at times the effused blood makes its way into the



iliac fossæ, gradually invades the renal region and eventually reaches the lower margin of the diaphragm.

Vulval hæmatomata of moderate size are usually absorbed spontaneously. In other cases the tissues covering the tumor may undergo pressure necrosis and give way, profuse hæmorrhage resulting, or the contents may be discharged in the form of large clots. In either event the interior of the hæmatoma is very prone to become infected, the condition sometimes ending fatally. If the tumor is large it not only causes discomfort by its mere size, but gives rise to great suffering, which becomes more intense the more rapidly it is formed, as the result of the tearing and stretching of the tissues.

In the subperitoneal variety such immense quantities of blood may be effused beneath the peritoneum that the patient rapidly succumbs to acute anæmia. In other cases a fatal issue follows secondary rupture into the peritoneal cavity, and many patients perish from infection. In 33 cases of this character which I collected in 1904 the mortality was 56 per cent. It is interesting to note that more than 60 per cent. of the cases occurred in primiparæ, and 71 per cent. after spontaneous labor. In my patient the hæmorrhage came from a vessel at the base of the bladder, which had become torn through during the course of a spontaneous labor.

A vulval hæmatoma is readily diagnosed by the sudden appearance at the vulva of a tense, elastic, fluctuating, and sensitive tumor of varying size, covered by discolored skin. When the mass develops in the vagina it may escape detection for a time, but the development of pressure symptoms soon leads to a vaginal examination, when a round, fluctuant tumor is found, which encroaches upon the lumen. On the other hand, when the hæmatoma extends upward between the folds of the broad ligament, it is liable to escape detection, unless symptoms of anæmia or infection appear. In my case the uterus was markedly displaced upward by the effused blood, and on bimanual examination a fluctuant tumor 15 centimeters in diameter could be palpated beneath it; although had the patient not been seen until after the infection had occurred, the differential diagnosis between such a condition and an extensive pelvic inflammatory mass would have been very difficult.

The prognosis is usually favorable, though very large hæmatomata occasionally lead to death from hæmorrhage, whereas in rare cases the fatal termination is the result of infection.

*Treatment.*—Small hæmatomata should be left alone, as spontaneous resorption usually takes place, provided the parts be kept clean and infection avoided. On the other hand, a steady increase in size indicates a continuance of hæmorrhage, and in such cases the tumor should be laid widely open and packed with gauze. The strictest antiseptic precautions are imperative, inasmuch as infection is a frequent complication. In large subperitoneal hæmatomata, accompanied by acute anæmia, laparotomy should be promptly performed, the blood clots removed, and the hæmorrhage controlled by ligature or by packing the cavity with gauze.

**Diseases and Abnormalities of the Uterus.**—*Subinvolution.*—This term is used to describe an arrest or retardation of the process of involution, by



which the puerperal uterus is normally restored to its original proportions.

Involution is the result of an autolytic process, which leads to atrophy of the individual muscle cells, rather than to fatty degeneration, as was formerly supposed. Its proximate cause is to be sought in the liberation of certain, as yet unknown, ferments associated with the sudden and marked diminution of the blood supply to the uterus. As this can be brought about only by satisfactory contraction and retraction of the organ, it is apparent that any interference with the process may be followed by subinvolution.

Among the most frequent factors concerned in its production are imperfect exfoliation of the decidua, retention of portions of the after-birth, inflammatory lesions of the endometrium, the presence of myomatous nodules in the uterine wall, abnormalities of circulation which frequently accompany displacements of the uterus, the existence of pelvic inflammatory lesions, and insufficient rest during the puerperium. In other words, subinvolution is practically always the result of local conditions and not of constitutional disorders, and accordingly careful investigation will reveal the underlying cause, and appropriate treatment, if undertaken sufficiently early, will lead to its cure.

The existence of subinvolution is manifested by a prolongation of the lochial discharge beyond the usual period, its cessation being followed by persistent leucorrhœa with pains in the back, a general feeling of dragginess, and a delayed return to perfect health. Similar symptoms accompany uterine displacements, but in all probability are in great part due to the coincident subinvolution. If the condition is not properly treated it may lead to permanent changes in the uterus, which are sometimes associated with such serious hæmorrhage as eventually to necessitate the removal of the organ. According to R. F. Smith, the uterus in such cases is abnormally large, contains much more fibrous and less muscular tissue than normally, while the arterial walls are so altered that the normal mechanism for the regulation of the circulation is in abeyance.

The diagnosis is established by bimanual examination, the uterus being found to be larger, softer, and more succulent than it should be at a given time following delivery. Normally the fundus should have descended to the level of the upper margin of the symphysis by the tenth day, although the organ does not regain its original size for six weeks after delivery.

Inasmuch as subinvolution is dependent mainly upon local conditions, very little can be expected from medicinal treatment, although the administration of a half dram of the fluid extract of ergot every three or four hours for several days is sometimes followed by improvement. Local measures afford much better results. If the uterus is displaced it should be put in proper position by bimanual manipulation and held in position by a suitably fitting pessary, and copious hot saline vaginal douches given twice a day. When disease of the endometrium or retention of portions of the after-birth is responsible, prompt curettage offers the most efficient method of treatment. On the other hand, procrastination may lead to serious results, as the subinvolution may become permanent.

*Lactation Atrophy of the Uterus.*—Ordinarily, in women who suckle their children, the uterus may undergo excessive involution, becoming



smaller than in the virginal state. This condition, which usually becomes most marked during the third or fourth month after delivery, is attributed to reflex irritation emanating from the breasts and incident to lactation and nursing. It usually disappears spontaneously after weaning, though when the child is nursed for a longer period than usual the uterus may begin to increase in size before the end of a year, even though lactation be continued. It is probable that the cessation of menstruation, which is usually observed during lactation, should be partly attributed to this form of atrophy.

The condition was first definitely described by Jacquet, in 1871, and since the publication of his paper has been carefully studied by numerous investigators, particularly Thorn, Gottschalk, Döderlein, and Vineberg.

In rare instances the atrophy may persist after weaning and become permanent, the uterine cavity sometimes measuring only a few centimeters in length. This abnormality, first described by Chiari, Braun, and Spaeth, in 1855, was later designated by Simpson as *superinvolution*. It is probable that it may occasionally be the causative factor in the unusually early appearance of the menopause.

*Displacements of the Uterus.*—Immediately following the birth of the child, the lower uterine segment and cervix are represented by a flabby, collapsed structure which is freely movable upon the rest of the organ (see Fig. 322). In these circumstances a comparatively trivial cause, such as a slight increase in the intra-abdominal pressure or distention of the rectum, may lead to an excessive bending forward of the body of the uterus—*ante flexion*. The condition is usually without significance, but occasionally the angle formed between the upper and lower portions of the organ may be so acute as to occlude the cervical canal and lead to the retention of the lochial discharge—*lochiometra*. As a rule the retention, when it occurs, is only transitory, but if it be prolonged the lochia may undergo putrefactive changes which are accompanied by the formation of toxins, the absorption of which may give rise to constitutional symptoms. The complication is readily overcome by allowing the retained discharge to drain away through a douche-tube, after which the uterine cavity should be irrigated with sterile salt solution.

So long as the body of the uterus lies above the superior strait, retro-displacement cannot occur, as the falling backward of the enlarged fundus is prevented by the promontory of the sacrum. But as soon as the organ has descended into the pelvic cavity a *retro flexion* or *retroversion* becomes possible. The development of such displacements, which are rarely observed before the third week of the puerperium, is probably connected with excessive relaxation of some of the structures about the base of the broad ligaments. This apparently results from overdistention by the presenting part, and is by no means always due to traumata incident to operative procedures, as in my experience retroflexion frequently follows normal spontaneous labors during which no apparent injury was sustained. It is possibly favored by the use of an abdominal binder which may cause the abdominal contents to exert pressure upon the fundus of the uterus, forcing it downward and backward. In other cases the retroflexion merely repre-



sents a recurrence of a similar condition existing prior to pregnancy, while occasionally it may be the result of extreme distention of the bladder.

Backward displacements of the uterus rarely give rise to symptoms so long as the patient remains in bed, but as soon as she begins to move about their presence is apt to cause more or less inconvenience. The earliest and most characteristic manifestation is a marked increase in the amount of lochial discharge or the reappearance of the flow if it has already ceased. Sometimes the patient suffers from pain in the back and lower abdomen, although in other cases she may only be conscious that she is not regaining her strength as rapidly as she had expected.

A positive diagnosis can always be made upon vaginal examination, when the displaced uterus will be found to be larger and softer than normal—in other words, the condition is usually associated with subinvolution.

The restoration of the uterus to its normal position by bimanual manipulations, and the introduction of a properly fitting pessary, as a rule will afford prompt relief, and on removal of the pessary some months later it will frequently be found that a permanent cure has resulted. On the other hand, if the pessary is not employed until after the conclusion of the puerperium, much less favorable results are obtained, while if deferred until some months later its employment is usually useless. This fact serves again to emphasize the necessity for making a final examination before discharging the puerperal patient. When the patient has suffered from retroflexion before pregnancy, an examination made at the end of the second week of the puerperium will usually show that the uterus has returned to its abnormal position. In such cases it should be replaced and a pessary at once introduced, although the prospects of a permanent cure are questionable.

*Relaxation of the Vaginal Outlet and Prolapse of the Uterus.*—Reference has already been made to the frequent occurrence of perineal lacerations at the time of labor and the consequent relaxation of the vaginal outlet which follows neglect to repair them.

Moreover, the changes following childbearing predispose to the occurrence of *prolapse of the uterus*, and an exacerbation should be expected during the puerperium in women who have presented moderate degrees of descensus uteri before labor. In order to obtain the best results, and to prevent serious disability, an early operation is imperative, since the difficulty of rectifying the condition depends largely upon the extent of the prolapse and the length of time that it has been allowed to exist.

**Delayed Chloroform Poisoning.**—Until very recently it was generally held that chloroform could be administered with impunity to the woman in labor. We now know that this is not the case, but that in rare instances symptoms of poisoning may set in several days after delivery and lead to death.

The investigations of Howland and Richards, and Whipple upon pregnant dogs show that the process consists essentially in an autolysis of the hepatic cells, which may lead to almost total destruction of the secretory portion of the liver. In extreme instances the cells occupying the center of each lobule are completely destroyed, so that only a margin of approxi-



mately normal cells is preserved at the periphery. Associated with these changes is a pronounced perversion of metabolism.

I have encountered the complication upon one occasion. In a primiparous woman dilatation of the cervix was completed manually and forceps applied on account of threatened foetal asphyxia, after which several lacerations were repaired. The anæsthetic was taken badly and was given for a little longer than one hour. The patient was in excellent condition for two days, but on the third day jaundice developed, and she passed into a torpid state, with occasional periods of excitement, and died in coma on the fifth day. At autopsy the liver presented an appearance similar to that observed in the early stages of acute yellow atrophy of the liver, and identical with that produced experimentally in dogs.

No doubt such cases were occasionally observed in the past, when death was attributed to some obscure toxæmia. In view of our present knowledge it behooves us to inquire whether we are justified in continuing to use chloroform as an anæsthetic. I believe that it may be safely employed for ordinary obstetrical anæsthesia, but that it should be replaced by ether whenever the operation and its preliminary preparations promise to last for longer than one half hour.

**Obstetrical Paralysis.**—Paralytic conditions may develop in either mother or child during the puerperium. That branches of the sacral plexus sometimes suffer from pressure during labor is demonstrated by the fact that many patients complain of intense neuralgia or of cramp-like pains extending down one or both legs as soon as the head begins to descend into the pelvic canal. As a rule, of course, the compression is rarely severe enough to give rise to grave lesions. In some instances, however, the pain continues after delivery, and is accompanied by the development of paralysis in the muscles supplied by the external popliteal nerve—the flexors of the ankles and the extensors of the toes—the gluteal muscles occasionally becoming affected to a lesser extent.

The subject has been carefully studied by Hünemann, H. M. Thomas, and Hösslin. The investigations of the former supplied a very satisfactory explanation of the common localization of the paralysis by showing that the external popliteal nerve receives fibers from the fourth and fifth lumbar roots, and that these on their way downward to join the sacral plexus pass over the brim of the pelvis, where they are exposed to danger from compression, whereas the lower roots which lie upon the pyriformis muscle are more protected.

Hünemann considers that the chances of injurious pressure are greatest where the pelvis is generally contracted, and less so in the rhachitic varieties, inasmuch as the projecting promontory in the latter tends to prevent the head from coming in contact with the nerves. In the majority of cases the injury is the result of direct pressure exerted by the child's head, and only exceptionally by the forceps.

In view of the fact that only one oblique diameter of the superior strait is occupied by the greatest diameter of the head, it is readily understood why the paralysis is usually limited to one leg, Thomas's case being the only instance on record in which both legs were affected. The paralytic



symptoms usually appear immediately after delivery, and may become permanent unless suitable therapeutic measures, more particularly the use of electricity, are promptly instituted.

In other cases paralytic symptoms, accompanied by intense neuralgic pains along the course of the sciatic nerve, follow pelvic inflammatory troubles. The condition is sometimes due to the development of a neuritis affecting certain branches of the sacral plexus, while in other cases pressure exerted by an inflammatory exudate is responsible. I have seen a case of the latter character, which had persisted for years in spite of continuous treatment, disappear as if by magic after laparotomy and the separation of the adherent appendages from the posterior and lateral portions of the pelvic wall.

Winscheid has directed particular attention to the rare cases of *neuritis* which follow delivery. The inflammation may be general or localized. In the latter only one or two nerves are affected—the median, ulnar, or crural—and atrophic symptoms soon make their appearance. In the former, since a number of nerves are implicated simultaneously, sometimes even those of the face not escaping, the symptoms may be manifold and the condition become most serious. In either event we are ignorant concerning the mode of production of the nerve lesions, though they are supposed to be due to toxæmic influences. The prognosis is fair for the localized but poor for the generalized variety.

It is also important to bear in mind that separation of the symphysis pubis, or of one or other sacro-iliac synchondrosis during labor, may be followed by pain, and by so marked an interference with locomotion as at first sight to suggest the existence of paralysis. Moreover, the disturbances in the function of the psoas muscles and the adductors of the thigh, which so frequently accompany the early stages of osteomalacia, might readily lead to a similar error.

In addition to these more localized processes the puerperal woman may occasionally suffer from paralysis of central origin. In most instances these result from various varieties of apoplexy, and occasionally from areas of cerebral degeneration incident to eclampsia and the other toxæmias.

As a result of a difficult labor, and exceptionally after an easy one, the child is sometimes born presenting an affection of the arm which is commonly known as *Duchenne's paralysis*. In this form, paralysis of the deltoid, infraspinatus, and the flexor muscles of the forearm causes the entire arm to fall close to the side of the body, and at the same time to rotate inward, while the forearm becomes extended upon the arm. The motility of the fingers is usually retained.

Erb pointed out that such a paralysis could be due only to a lesion involving the fifth and sixth roots of the brachial plexus, and showed that electrical stimulation at a point from 2 to 3 centimeters above the clavicle and in front of the transverse process of the sixth cervical vertebra—now known as Erb's point—produces contractions of the muscles involved. He considered that the paralysis frequently follows compression of the plexus by the clavicle in the Prague method of extraction, more particularly when the arms have become extended over the head. In other

cases its production is attributed to traction with the fingers in the axilla of the child, and occasionally to the use of forceps.

That compression may be exerted during the employment of either of the first two of these manœuvres is at once evident from a consideration of the anatomical relations. On the other hand, the experiments of Stolper show that the plexus cannot possibly be compressed by the tips of the forceps so long as the child presents by the vertex, although it may occur in face or brow presentations.

Carter, in 1893, was the first to direct attention to the fact that the condition is due to stretching of the upper roots of the brachial plexus more frequently than to abnormal pressure. His results were confirmed by the experimental work of Fieux, Schumaker, and Stolper, all of whom demonstrated that the plexus was readily subjected to extreme tension as a result of pulling obliquely upon the head, thus sharply flexing it toward one or other shoulder. As traction in this direction is frequently employed in order to effect delivery of the shoulders in vertex presentations, it is readily seen that Duchenne's paralysis might follow comparatively simple or even spontaneous labors. In view of these considerations, therefore, in extracting the shoulders care should be taken not to bring about too great lateral flexion of the neck. Moreover, in breech extractions the Prague manœuvre should be employed only when absolutely necessary, and particular attention should be devoted to preventing the extension of the arms over the head, as it not only materially complicates delivery, but adds considerably to the danger of infantile paralysis.

The *prognosis* is usually fair, the majority of the children recovering. Occasionally, however, a case may resist all treatment and the child may remain hopelessly paralyzed. All of the instances which I have personally observed ended in recovery, but in some of them prolonged treatment was necessary. In this form of paralysis the children should be promptly put under the care of a competent neurologist, as the intelligent use of the electrical current is frequently the only means by which degenerative changes in the nerves and muscles can be obviated, and neglect in this regard may result in the condition becoming permanent.

**Abnormalities and Diseases of the Breasts.**—Complete *absence of both breasts* is one of the rarest anomalies of development, while the absence of one and the normal development of the other breast have been noted in a few isolated cases.

*Hypertrophy of the breasts* is more often observed, but is nevertheless an infrequent occurrence. In a large proportion of the recorded cases the condition developed rapidly in young unmarried women, both breasts being implicated and occasionally attaining such immense proportions that amputation became necessary. Cases have been reported in which a single breast weighed more than 50 pounds. The hypertrophy sometimes recedes during lactation, so that the abnormality does not always afford an absolute contra-indication to suckling the child. Overdevelopment of the mammae is sometimes observed in men, a number of cases having been collected by Laurent.

*Supernumerary Breasts.*—Probably one in every few hundred women



has one or more accessory breasts—*polymastia*. Reference to 262 such cases are to be found in Goldberger's article.

The supernumerary breasts rarely attain any considerable size, and occasionally are so minute as to be mistaken for small pigmented moles. They are often provided with distinct nipples. They are most commonly situated upon the anterior thoracic or abdominal walls, usually near the mammary line; less frequently they are found in the axillæ, and occasionally upon other portions of the body—the shoulder, flank, or groin, and in rare instances the thigh. They vary greatly in number, Neugebauer having described a patient with 10 breasts.

The condition is usually regarded as an atavistic reversion, though it is not associated with an increased tendency toward multiple pregnancy. In not a few instances an apparent hereditary influence can be traced. Not all observers, however, accept this view, Ahlfeld holding that the distribution of the mammary tissue is to be attributed to the transference at an early period of development by means of the amnion of some of the cells, which ordinarily go to form the breasts, to other portions of the body. The condition has no obstetrical significance, though occasionally the enlargement of supernumerary breasts occupying the axillæ may result in considerable discomfort to the patient.

*Abnormalities of the Nipples.*—The typical nipple is cylindrical in shape and projects well beyond the general surface of the breast, its exterior being slightly nodular but free from fissures. Variations from the normal, however, are not uncommon, some of them being so pronounced as to interfere seriously with the act of suckling.

In some women the lactiferous ducts open directly into an area which forms a depression at the center of the areola. In pronounced instances of this so-called *depressed nipple* nursing is out of the question, although when the depression is not very deep the breast may occasionally be made available by the employment of a nipple-shield.

More frequently, although not depressed, the nipple is so stunted that it hardly projects above the surface of the breast, and in consequence can be seized by the child's mouth only with the greatest difficulty. In the presence of this anomaly daily attempts should be made during the last few months of pregnancy to draw the nipple out by traction with the fingers, and a wooden nipple-shield should be constantly worn in the hope that by exerting pressure upon the periphery of the areola the nipple itself may be gradually made to protrude through the opening of the shield.

Again, it sometimes happens that nipples which are normal in shape and size may present so fissured or nodular a surface as to be especially susceptible to injury from the child's mouth during the act of suckling. In such cases small cracks or *fissures* almost inevitably appear, and render nursing so painful that the mother dreads the approach of the child, and the mental distress so induced often has a deleterious influence upon the secretory function. Moreover, such injuries are still more serious in that they offer a convenient portal of entry for pyogenic bacteria which are liable to invade the breast and give rise to a mastitis.

*Abnormalities in the Mammary Secretion.*—Marked individual varia-



tions exist in the amount of milk secreted, many of which are dependent not upon the general health and appearance of the individual, but upon the degree of development of the glandular portions of the breasts. Thus we often find that a woman who possesses large, well-formed breasts, and who apparently should be an excellent milk-producer, secretes only a small quantity; while, on the other hand, one is often surprised at the abundant supply produced by another whose mammaræ are small and flat. It is a matter of common observation that stout women with well-formed but redundant breasts usually have a very deficient secretion, the bulk of the organ being made up of fatty tissue while the glandular elements are poorly developed. Deficient secretion is likewise frequently noted in very young women and in elderly primiparæ. In the former the defect is to be attributed to imperfect development; in the latter to regressive and atrophic changes in the breasts.

In very rare instances there is an absolute lack of mammary secretion—*agalacia*. As a rule, however, the defect is not absolute, as it is nearly always possible to cause at least a small amount to exude from the nipple on the third or fourth day of the puerperium. On the other hand, relative deficiency is frequently observed, a large number of women secreting an amount of milk quite insufficient for the nutrition of the child. In Chapter XVII reference was made to the variations in the quantity of the milk as well as the various factors which may be concerned in their production.

Occasionally the mammary secretion is excessive—*polygalacia*—and may even be so abundant that milk is constantly escaping from the nipples. This latter condition, which is known as *galactorrhœa*, sometimes continues for years after the birth of the child, and is extremely intractable to treatment. Nothing is known as to its cause. Although in rare instances the health of the woman may remain unimpaired, as a rule she soon begins to show evidences of the continuous drain upon her system, becoming irritable, querulous, and eventually developing symptoms of cachexia.

Galactorrhœa is best treated by not attempting to empty the breast, but rather by allowing it to become engorged, when the intramammary pressure becomes so great as to compress the vessels and thus check secretion. At the same time the breasts should be supported by a bandage, and fairly large doses of potassium iodide should be administered. Good effects are also said to have been obtained from the use of chloral. In a certain number of cases the condition is combined with atrophy of the uterus, and several observers have reported improvement following procedures which tend to bring about an increase in size of the uterus, such as the use of the vaginal douche, local applications to the cervix, or the employment of electricity.

*Diseases of the Nipples.*—The mode of production and treatment of fissures of the nipples has already been considered in detail in Chapter XVII.

*Engorgement of the Breasts.*—For the first twenty-four or forty-eight hours following the development of the lacteal secretion, it is not unusual for the breasts to become immensely distended, and to offer on palpation a firm, nodular resistance. This condition, which is commonly known as "*caked breast*," often gives rise to a considerable degree of pain, and is fre-



quently accompanied by a slight elevation of temperature. Within a day or so the engorgement usually passes off spontaneously, or as the result of appropriate treatment, though in some cases it persists in spite of all that can be done, and may be a forerunner of the development of a mammary abscess. It is probable that the excessive distention of the glandular portion of the breast leads to slight tissue changes, thereby offering a *locus minoris resistentiæ* for invasion by bacteria, which are usually present in the lactiferous ducts.

Whenever the breast becomes markedly engorged immediate steps should be taken to relieve the condition. This is most readily accomplished by drawing the breasts firmly against the thorax by means of a tight binder, and if necessary giving  $\frac{1}{4}$  grain of codia, which may be repeated in three hours if necessary. Usually this will relieve the condition within twenty-four hours, and the physician is cautioned not to be too hasty in resorting to other measures.

If the engorgement does not show signs of subsiding within this period, and particularly when the child is unable to draw off a sufficient quantity of milk, an English breast-pump should be employed to remove the excess. Sometimes this procedure proves ineffectual, and relief can be obtained only by proper massage. The nurse having anointed the palmar surfaces of her hands with olive-oil, mixed with equal parts of laudanum if the breasts are very sensitive, makes stroking movements, beginning at the periphery of the breast and gradually approaching the nipple. At first the manipulations should be made very gently, but as the patient becomes accustomed to them more force may be employed, which will soon cause the milk to exude from the nipple. After the breast has been emptied the bandage should be reapplied, as it not only relieves pain by preventing the overloaded organ from sagging downward, but at the same time serves to diminish the amount of secretion by diminishing the blood supply. That the engorgement is usually transient and the use of special treatment is unnecessary is clearly shown by the fact that I have not employed massage or the breast pump for years. In many instances I believe that the use of these measures often defeats the very purpose for which they are employed, as they stimulate rather than diminish the secretory activity of the breasts.

*Drying up the Breasts.*—After the death of the child, or in cases in which for one reason or another the continuance of lactation is thought inadvisable, steps must be taken for checking the lacteal secretion, or “drying up the milk,” as it is usually designated. Formerly this was accomplished by the use of the binder, the application of belladonna ointment, and the employment of the breast-pump and massage when the engorgement became pronounced. The process was frequently very painful to the patient, very troublesome to the nurse, and usually had to be employed for a week or ten days or even longer before the desired result was obtained.

In 1904 Dr. E. R. Lewis, of Westerly, R. I., told me that such treatment was unnecessary, and that much more satisfactory results could be obtained by the administration of 20 grains of potassium acetate every six hours. I immediately put his suggestion into practice, and found that the breasts dried up in the course of two to four days without other treat-

ment. Further investigations, however, showed that the potassium acetate was of no value, as equally satisfactory results followed if drugs were not used.

Accordingly, when it is desired to "dry up" the breasts, they are left absolutely alone. In the course of twenty-four hours they become more or less engorged, and sometimes very painful. If the pain is severe,  $\frac{1}{4}$  grain of codia is administered, and repeated if necessary, but the breast-pump or massage is not employed. Within a few hours the engorgement begins to subside spontaneously and the amount of secretion to decrease, so that by the end of another twenty-four hours the breasts become soft and painless. With each succeeding day the secretion becomes less and less abundant, and practically disappears in the course of a week.

Since I have employed this method I have entirely abandoned the use of belladonna ointment, the breast-pump, and massage, as well as the tight breast binder, though when the breasts are large and pendulous they may be held in position by a loose bandage. H. J. Storrs, in 1909, published a report of the cases so treated in my clinic, and stated that not a single breast abscess had developed, and that less than one woman in ten complained of sufficient pain to necessitate the administration of a sedative.

*Inflammation of the Breasts—Mastitis.*—Parenchymatous inflammation of the mammary glands is a not infrequent complication of the puerperium. The symptoms rarely appear before the end of the first week, and as a rule not until considerably later. Marked engorgement usually precedes the inflammatory trouble, the first sign of which is afforded by chilly sensations or an actual rigor, which is soon followed by a considerable rise in temperature and an increase in the rate of the pulse. The breast becomes hard, its surface is reddened, and the patient complains of acute pain. In many instances, by the end of twenty-four hours the condition disappears spontaneously without treatment, being often favorably influenced by the application of a tightly fitting bandage. But if the symptoms persist for longer than forty-eight hours, suppuration is to be expected. The process may remain limited to a single lobe if the abscess is opened promptly; but if left to itself the breast is liable to become undermined in all directions, and, as a result, the destruction of tissue is extensive, and the external surface may be left riddled with numerous fistulous tracts.

In some cases the constitutional symptoms attending a mammary abscess are very marked, and sometimes lead to a fatal termination, whereas the local manifestations may be so slight as to escape observation. Such cases are usually mistaken for puerperal infection, and give rise to no little anxiety until the examination of cultures from the uterine cavity has demonstrated the absence of bacteria. On the other hand, a certain number of cases pursue a subacute or almost chronic course, the breast being somewhat harder than usual and more or less painful, but constitutional symptoms are either lacking or very slight. Under such circumstances the first indication of the true state of affairs is often afforded by the detection of fluctuation.

*Ætiology.*—Mastitis is always the result of infection, pathogenic bacteria from outside gaining access to the breast through fissured nipples



by way of the lymphatics; or else some of those already present in the lactiferous ducts meet with conditions which enable them to invade the tissues. The researches of Bumm, Hönigmann, Koestlin, and others have demonstrated that *Staphylococcus albus* is present in 80 to 94 per cent. of all breasts. Ordinarily this micro-organism lives in the milk as a harmless parasite, but when the tissues are seriously altered as the result of engorgement, it is possible for it to become pathogenic. Rubeska reported the following bacteriological findings in 16 cases of mammary abscess:

|                                                     |         |
|-----------------------------------------------------|---------|
| <i>Staphylococcus aureus</i> .....                  | 9 cases |
| <i>Staphylococcus aureus</i> and <i>albus</i> ..... | 9 "     |
| <i>Staphylococcus albus</i> .....                   | 3 "     |
| <i>Streptococcus</i> .....                          | 1 case  |

Exceptionally, other bacteria are causative agents, Sarfert having demonstrated the gonococcus, Chassot the bacillus pyocyaneus, and Little the gas bacillus.

When the infection occurs through fissured nipples the inflammation is usually phlegmonous in character. In some cases it involves only the connective tissue beneath the breast, a large collection of pus being formed between it and the thoracic wall—retromammary abscess. Again, the infection may be limited to the areola, beneath which small abscesses, rarely exceeding 1.5 centimeters in diameter, may develop—*subareolar mastitis*. In rare instances the affection may be erysipelatous in character, and be limited to the superficial tissues.

According to Winckel, 67.6 per cent. of all cases of mastitis occur in primiparae, but its actual incidence varies according to the care given the patients during pregnancy and the puerperium. Thus, the statistics of Rubeska show a frequency of 0.54 to 4.1 per cent. in the various German clinics. Generally speaking, it may be said that the frequent occurrence of mastitis is indicative of neglect on the part of the physician or nurse.

*Treatment.*—The occurrence of mastitis can be prevented in great part by suitable prophylactic measures, which mainly consist in preventing the development of fissured nipples or treating them properly after they have appeared.

The most suitable measures for hardening the nipples during pregnancy, so as to enable them to better withstand the strain of nursing, have already been mentioned in Chapter XVII. When lactation becomes established the strictest cleanliness should be observed and the nipples watched most carefully. As soon as a fissure begins to develop a nipple-shield should be employed, the child not being allowed to apply the mouth directly to the nipple until healing has taken place. In the intervals between the feedings the sore nipple should be covered with a piece of absorbent cotton soaked in a saturated solution of boric acid. The various applications which are usually recommended, however good in themselves, will prove practically valueless unless the nipple can be placed at comparative rest, which is best afforded by the use of a suitable nipple-shield. If the condition becomes worse after some days' trial of this treatment it is ad-

visible to wean the child rather than take the risk of infection, which is so prone to follow if the deeply fissured nipple be used for any length of time.

On the first symptom of mammary infection the breast should be put at rest as far as possible by not allowing the child to nurse it, and withdrawing the milk, if necessary, by means of a breast-pump. After being emptied the breast should be thickly covered with cotton, and by means of a tightly fitting bandage subjected to the greatest possible pressure consistent with the comfort of the patient. In many cases such treatment apparently cuts short the process, the symptoms disappearing within twenty-four hours, after which the patient is able to resume suckling her child. Usually, however, the process sooner or later eventuates in abscess formation. In early cases Bier reports excellent results following the use of his method of artificial hyperæmia, but in my service the procedure has been of little value.

As soon as the slightest evidence of fluctuation can be obtained the breast should be incised. Procrastination is not permissible, delay being synonymous with extension of the process, which frequently leads to such extensive destruction of tissue as to destroy permanently the physiological function of the organ. The incision should be made radially, extending from near the areolar margin toward the periphery of the gland, in order to avoid injury to the lactiferous ducts. In early cases a single incision over the most dependent portion of the area of fluctuation is usually sufficient, but when multiple abscesses are present several incisions may be required. The operation should always be done under anæsthesia, and should not be considered as completed until the obstetrician has introduced a finger through the incision and carefully explored the interior of the breast, breaking down the partition walls between the various pockets of pus, so that only a single abscess cavity is left to be dealt with. This should then be loosely packed with gauze, which is removed at the end of twenty-four hours and the cavity washed out with sterile salt solution or a 2-per-cent. boric-acid solution, after which another pack is inserted. If the pus has been thoroughly evacuated, the abscess cavity becomes obliterated with a rapidity which is sometimes surprising.

*Galactocoele.*—Very exceptionally, as the result of the clogging of a milk duct by inspissated secretion, an accumulation of milk may take place in one or more lobes of the breast. Ordinarily this is limited in amount, but may become excessive and form a fluctuant tumor which may give rise to pressure symptoms. In many instances massage and the application of a tight bandage will cause it to disappear, while in others the structure may attain such a size that puncture becomes imperative.

**Puerperal Psychoses.**—Reference has already been made to the alterations in the mental condition which may accompany pregnancy. These vary from slight changes in disposition to actual insanity, though fortunately the latter is of relatively rare occurrence.

The insanity of pregnancy is usually a manifestation of auto-intoxication, and may be accompanied by melancholic or maniacal symptoms. It usually persists throughout the remainder of gestation, but disappears



shortly after labor, unless the patient has an hereditary tendency to mental derangement.

*Puerperal insanity*, on the other hand, is much more common, and according to the statistics compiled by Berkley and Jones is noted once in every 616 and 1,100 labors, respectively, though my experience would lead me to believe it less frequent. In former times it was a comparatively common complication, and it would seem that the introduction of aseptic methods into midwifery is responsible for a reduction by one half in its incidence. The affection usually makes its appearance within the first two weeks following delivery. When it occurs at a later period it is designated as *lactational insanity*.

Puerperal psychoses may be due to one of three causes: infection, auto-intoxication, or direct lability of the nervous system. Of these, the former is by far the most important. This fact has long been recognized, but it is only of late that the bacteria concerned have been identified, and then only in a small proportion of the cases. In 2 of the 3 instances which have come under my observation the infection was due to streptococcus, and in the third to the streptococcus and colon bacillus. Berkley likewise reports a case due to the organism first mentioned.

Auto-intoxication is also a frequent ætiological factor, and is probably usually concerned in the production of the mental derangements following eclampsia. Ordinarily, insanity is regarded as a rare complication of eclampsia, though Olshausen observed it in 6 per cent. of his 515 cases. According to Hansen and Picqué, infection and auto-intoxication are responsible for more than 80 per cent. of all cases, while the remainder are to be attributed to other causes, occurring particularly in women afflicted with hereditary tendencies, the exciting cause of the insanity being shock, extreme mental depression, or the rapid loss of a large quantity of blood.

The puerperal psychoses are usually characterized by great excitement during the first few days, associated with all sorts of hallucinations. Later the maniacal symptoms disappear, and the patient passes into a condition of depression, and frequently exhibits suicidal tendencies.

The prognosis is most favorable in the cases following eclampsia, the majority of these patients recovering within a few weeks. On the other hand, those following infection are very tedious, and 20 to 40 per cent. of the women fail to regain their mental equilibrium. It is not unusual for the disturbance to last for from three to six months, although the prospect for recovery is poor if the latter period is exceeded. It is generally stated that from 5 to 10 per cent. of the patients afflicted with puerperal insanity die, this high mortality rate being due, of course, to the underlying infection and not to the mental derangement itself.

In cases following infection the treatment should first be directed to the underlying condition, and the directions described in Chapter XLIII rigorously followed. The acute maniacal symptoms should be met by the administration of sedatives, and the patient should be watched most carefully throughout her entire illness, more particularly during the periods of depression, during which she should never be left alone for fear that she may do an injury to herself. If prompt improvement does not follow the dis-



appearance of the symptoms ascribable to infection, the patient should be placed in charge of a competent psychiatrist.

**Typhoid Fever.**—This is not an infrequent complication of the puerperium. Its course, however, varies but little from that observed under other conditions, although the prognosis is necessarily somewhat influenced by the fact that the patient is already debilitated by the strain incident to labor. The diagnosis should never be made unless a definite Widal reaction can be demonstrated, inasmuch as all the other symptoms of the disease may be associated with a prolonged puerperal infection, especially when the endocardium is involved. Furthermore, the so-called typhoid condition is often encountered in various forms of pyæmia.

**Malarial Fever.**—In certain districts the puerperium is sometimes complicated by malarial infection. Although the course of the disease is not materially influenced by the fact that the patient has recently given birth to a child, it is interesting to note that labor, no less than surgical procedures, seems to predispose to a recrudescence of the disorder in women who have already suffered from it, the typical phenomena often appearing during the first few days of the puerperium.

Too many sins of omission and commission on the part of the obstetrician have undoubtedly been cloaked under the diagnosis of "malaria." At the present day, whenever a patient presents a temperature characterized by marked remissions and possibly by chills, puerperal infection should be suspected, and the existence of malarial fever should never be seriously entertained unless all other possibilities have been practically eliminated and the characteristic parasites have been found in the blood.

As soon as a positive diagnosis has been made, quinine should be given in sufficiently large doses to break up the attack, as it exerts no appreciable influence upon the mammary secretion or the well-being of the child.

**Pneumonia.**—Croupous pneumonia is a rare complication of the puerperal state, unless the disease has existed before the onset of labor. The outlook is always serious.

The lobular variety, or broncho-pneumonia, is often a terminal process, and is one of the most common causes of death in patients who succumb within a few days following an eclamptic attack. The treatment does not differ essentially from that employed at other times.

**Scarlet Fever.**—Although scarlet fever is rarely encountered during the puerperium, its occurrence has given rise to a great deal of discussion and a very considerable literature. The interest manifested in the disease is largely to be accounted for by the fact that a scarlatiniform rash is occasionally observed during the course of a puerperal infection, so that in many cases a differential diagnosis becomes very difficult.

Epidemics of scarlet fever in the puerperium have been reported by Boxall, Meyer, Ahlfeld, and others. Nevertheless, it would appear that the puerperal woman is to a certain extent immune from the disease, inasmuch as statistics go to show that only a small proportion of those exposed to the contagion become infected. Thus, Meyer found the rate of morbidity to be about 1 per cent. among his patients.

It is generally stated that infection may occur in the usual manner, as



well as by the entrance of the specific poison through wounds about the genitalia. The belief in the possibility of the latter eventuality is based upon the fact that the rash occasionally appears first in the neighborhood of the vulva, and thence spreads to other portions of the body. Moreover, the frequent association of pelvic inflammatory troubles, and the occasional localization of diphtheritic patches in the vulva or vagina, instead of in the throat, are advanced in support of the view. Modern bacteriological investigation, however, has destroyed the force of this last argument, since it has shown that the so-called diphtheritic deposits occurring in the throat in scarlet fever are due to a coincident streptococcic infection. Moreover, since such conditions about the genitalia usually have a similar origin, it would appear difficult to differentiate between those complicating scarlet fever and the varieties occurring during the course of puerperal infection. It is also urged that the appearance of the disease on the third or fourth day of the puerperium speaks in favor of transmission of contagion through the genitalia.

In frank cases the diagnosis is readily made from the existence of a characteristic rash, which is later followed by desquamation. Moreover, the strawberry tongue, the development of pseudo-diphtheritic patches in the pharynx, the appearance of albumin in the urine, together with a history of exposure to possible contagion, usually remove all doubt. On the other hand, in the absence of characteristic manifestations, the diagnosis cannot be made, it being often impossible to differentiate between scarlet fever and puerperal infection, even when a distinct history of exposure to contagion can be elicited.

The prognosis is largely the same as under other circumstances, mild forms, as a rule, ending in recovery, whereas patients affected with the hæmorrhagic variety usually die. The puerperium appears to exert little effect upon the course of the disease, the death-rate not being higher than under ordinary conditions. The child may or may not be infected.

**Measles and small-pox** occasionally occur during the puerperium, but their course does not differ materially from that observed in women who have not recently given birth to children.

**Diphtheria.**—True diphtheritic patches, in which the Klebs-Loeffler bacillus can be demonstrated, occasionally occur upon denuded portions of the vulva and vagina. They may be due to a primary genital infection, or be merely part of a process primarily localized in the throat. Inasmuch as pseudo-diphtheritic patches in the genital tract during the course of puerperal infection are of frequent occurrence, the presence of fibrinous exudates about the vagina or vulva should lead to a diagnosis of diphtheria only in those cases in which the characteristic bacilli can be demonstrated. If the process is limited to the genital tract, the constitutional symptoms are not severe, and the disease usually pursues a benign course, readily yielding to the employment of the anti-diphtheritic serum.

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